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THESIS

MAPPING POPULATIONS: AN OBJECTIVE
MEASUREMENT OF REVOLUTIONARY DYNAMICS

by

David Gaugush
Gregory Merkl
Nicholas Thompson

June 2013

Thesis Co-Advisors: William P. Fox
                                             Guillermo Owen

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This work proposes a mathematical paradigm for modeling the rise and fall of coalitions during intrastate conflicts. It proposes that misalignment of preferences within constituencies drives instability, which can lead to revolution. To arrive at preference for an issue, the model considers two components: ideology and fervor. It shows that ideology tends to remain static while fervor changes rapidly. With the preferences of a society mapped according to constituents' ideology and fervor, the model then considers how coalitions exercise control in their quests for dominance.

The model builds upon the foundation of expert thought on intrastate conflict. It uses their generally qualitative assessments and employs measurable data and linear algebra to give a more formal depiction of the dynamics at play. Mapping populations in this manner may give insight into optimal strategies for eliciting stability or instability in a state. Using a hypothetical country in a developing revolution, the work implements the map to depict a government's attempts to stabilize a devolving intrastate system. It shows how rival coalitions can rapidly rise from irrelevance to preeminence by manipulating fervor. The work concludes by depicting the impacts of various third-party strategies for intervening in intrastate conflicts.

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MAPPING POPULATIONS: AN OBJECTIVE MEASUREMENT OF REVOLUTIONARY DYNAMICS

David Gaugush
Major, United States Army
B.A., Sam Houston State University, 2003

Gregory Merkl
Major, United States Army
B.S., West Point, 2002

Nicholas Thompson
Major, United States Army
B.A., University of Montana, 2000

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June 2013**

Authors: David Gaugush
                Gregory Merkl
                Nicholas Thompson

Approved by: William P. Fox
                Thesis Co-Advisor

                Guillermo Owen
                Thesis Co-Advisor

                John Arquilla
                Chair, Department of Defense Analysis

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GLOSSARY

Artificial Control: populace compliance based on the government's use of force or payment to buy allegiance.

Disequilibrium: the divergence of values and social mores once shared by governments and the societies they seek to govern.

Fervor: the passion a given person or coalition feels for one or more issues.

Ideology: how a person associates with a given issue.

Intrastate Conflict: sustained combat between or among armed forces that takes place within territorial boundaries of a state system member and leads to 1,000 battle related deaths annually.

Natural Control: when the populace recognizes the government's legitimate rule and complies with its authority.

Preference: the composite of fervor and ideology.

Revolutionary Potential: is the degree to which a state and the society it governs are in disequilibrium.

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I.   INTRODUCTION

A.   INTRODUCTION

Mapping populations, according to issues with *revolutionary potential*, provides the various leaders and decision makers within a government with cartographic depictions of demographic topography. In 1973 two ancient silken maps from the second century B.C. were excavated from the tomb of a Hunan prime minister's son.[1] One was a detailed terrain map of China from Hunan province to the South China Sea.[2] The second described the defenses of the kingdom after more than a decade of war.[3] Such rich history reveals that maps have been an essential component of strategy development for millennia.

Today, military tacticians and civilian planners use maps to deploy forces and plan cities. Each seeks to maximize their strategy either against a military enemy, as the tactician can attest, or against the ravages of time and the pressures of a budget, as the civil planner may argue. Thorough comprehension of the terrain, coupled with the proper use of military and civilian resources, has favored the meticulous analyst over time.

Employing resources with respect to terrain, time, and enemy are not the only factors in war. The lessons of Vietnam, Iraq, and Afghanistan have taught us the value of understanding all of the factors in conflict. We have found that now—more than ever—we need the support of the populace to resolve conflicts. The fundamental nature of conflict has not changed in the Information Age, but the global state of affairs emphasizes the necessity of documenting and analyzing the human terrain to the same accuracy modern day cartographers can map the Earth.

As power with global interests, the United States must achieve a greater level of resolution of the forces at play in foreign nations. Essentially, ideologically-based

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[1] John Noble Wilford, *The Mapmakers* (New York: Alfred A. Knopf, 1981), 8.

[2] Wilford, *The Mapmakers*, 8.

[3] Wilford, *The Mapmakers*, 8.

coalitions are unknown until conflict has already emerged; the population map provides a route to successfully navigate the many obstacles that nations face on the path to stability.

Governments can be empowered by or topple at the hands of their citizens. A recent illustration of this phenomenon was all too apparent across northern Africa and the Middle East with the onset of the Arab Spring in 2011, and continues to this day. Numerous claims of unpredictability and analytical ineptness on the part of academics and government officials were the common threads between the various sources of media and public debate on the subject. The people of the region were calling for change long before the self-immolation of the Tunisian merchant.

Why did the signs go unnoticed? This work contends that the signs were overlooked in part due to a lack of knowledge by international bodies and governments of nations. Their failure to assign the appropriate level of significance to the inherent social dynamics within countries like Tunisia, Egypt, Syria, and Libya prevented analysts from appreciating the tenuous circumstances.

The various domestic coalitions in each state held the key to illuminating the ideological stance of the people and their relative distance from the government. President Barack Obama publicly offered U.S. moral support for the people of the afflicted region while calling for some regimes to reform and others to step down. These societies were internally and externally unified against their respective authoritarian regimes, until the leadership stepped down, or in Muammar Gadhafi's case, was eliminated.

The upheaval and regional disruption throughout the Middle East challenged the United States' ability to comprehend the diversity and homogeneity of the issues at center stage; furthermore the international community failed to notice the importance of identifying the other political issues waiting to be addressed. Power brokers at the head of a multitude of coalitions and latent issues fueled the internal political conflicts. The unique transnational situation hindered the development of strategic options for the United States and its allies largely due to confusing rhetoric not founded on objective analysis.

In the past, negotiating the internal dynamics of a foreign population under tenuous circumstances, like those posed during the Arab Spring, required recondite knowledge of a state's internal coalitions at play. Knowing who should be coopted for achieving common national interest and identifying the parties within states that will breed political discontent and instability is available with the population map created in this work. A population map groups coalitions based on their ideological positions and passion for issues that have the capacity to incite revolutionary behavior. The map creates a more complete strategic picture.

1.   Purpose

This work introduces a contemporary mapping technique to display and compare the fervor of ideologically-based coalitions within a given society. To illustrate the technique's capabilities, this work depicts a hypothetical intrastate conflict scenario through an examination of the conflict as analysts would use the map to determine strategies.

Thoroughly understanding the ideological positions of the coalitions in play enables the analyst to attain an objective measurement for a country's societal priorities. The *fervor*, or passion, with which individuals in coalitions express and endorse their *ideology,* is a paramount component. The composite of ideology and fervor yields *preference*, which dictates the shape of the map.

The population map identifies the various coalitions and their position on issues (e.g., social, governmental, and economic), depicted by relative position to other coalitions, that are critical to understanding the political stability of the nation-state.

Issues of importance to the citizenry are the fundamental building blocks that lead to political stability or sow the seeds of revolution. This population map focuses on issues that harness *revolutionary potential*, and allows the analytical strategists to maneuver societal dynamics in order to build or fracture coalitions for achieving the desired outcome.

To effect meaningful change, it is necessary for governments and interventionists to develop a clear picture of the societal terrain beyond the scope of demographic surveys. The mathematical model proposed by this thesis has many uses. This work describes the tool as an objective, visual display that depicts the relative unity or disjointedness between societies and their governments. Internally, the model gives coalitions insight into strategies for obtaining a relative advantage over adversaries. Externally, it also proposes a methodology for intervening actors to determine which coalition is in their national interests to support.

Ignorant of the population's position on contentious issues and the dynamics between the existing and emerging coalitions, the interventionist is uncertain of who to support to maximize its gains.

This work establishes a unique definition of a population's *preference* for an issue as a function of *fervor* and *ideology*. Furthermore, arguing that a true gauge of a population requires a measure of both, this work integrates *artificial* and *natural control* into the map as a barometer for stability.

The ideology measures one's position with a given issue from complete opposition to complete support. Yet, a person who supports two issues will almost surely prioritize one over the other. Naturally, the person has greater fervor for the higher priority issue. In this sense, fervor scales the ideology of an individual. We examine how ideology changes slowly, if at all, and requires huge investments to alter. On the contrary, fervor—which is the passion felt for a given issue in a single snapshot—changes rapidly.

The combination of ideology and fervor for a surveyed population yields a population's preference distribution curve for an issue. Our model considers all of the issues that matter to a society, and places them into an objective map that gives the population density for each possible combination of positions for multiple issues. In other words, we take several distribution curves to produce a single distribution surface, which is depicted graphically for ease of use. Establishing a mathematical model that provides an objective paradigm of populations provides leaders with the confidence to trust subjective decisions.

2. Scope

Revolutionary potential is the degree to which a state and the society it governs are in disequilibrium.[4] Mapping populations, according to issues with revolutionary potential, provides the various leaders and decision makers within the government with cartographic depictions of demographic topography, which illuminates strategic options for achieving United States objectives. U.S. involvement in Iraq and Afghanistan attests to the importance of a comprehensive collection of information that informs the warrior-diplomat where consensus and disagreement exists. Population mapping along these research lines serves to empower our service members and government employees with the ability to influence political outcomes according to our national interests.

B. OUTLINE

Chapter I, "Introduction," provides the body of research necessary to establish the theoretical framework for the mathematical model. Initially the chapter lays the contextual foundation for the reader to understand the revolutionary dynamics of a society revealed through a close examination of the equilibrated relationship between society and state. This sets the stage for a look into intrastate conflict, how it is defined, categorized, and fueled by a complex host of factors that leads to revolutionary conduct. Third-party intervention is reviewed to reveal the propensity with which it is executed, its importance to bring about strategic results on behalf of the actor, and as the primary role fulfilled by the United States or NATO in intrastate conflict. Next, the principle components of the population map are introduced—ideology (the shape of the preference curve) and fervor (the scale of the preference curve). Last, a discussion on social movements is introduced to benefit the reader's conception of collective conduct toward coalition objectives.

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[4] Chalmers Johnson, *Revolutionary Change* (Stanford: Stanford University Press, 1982), 74–75. Johnson does not turn the phrase, "revolutionary potential," in his book. However, in the chapter titled: "The Disequilibriated Social System," Johnson describes in depth the concept that the values once shared by governments and the societies they seek to govern diverge. The divergence, regardless of the causes, leave the state in a position where the potential for a revolution is comparatively higher than when the government and society are more ideologically and legally aligned.

Chapter II, "The Model," utilizes ideology and fervor in the context of the model. Also, the chapter investigates the deductive steps to build the model in detail. The chapter begins by explaining how the model is an intuitive method of building the map. As the chapter progresses an explanation of how coalitions with similar ideologies naturally align sets up the following section. Introducing the concept of assisted preference and how to co-opt coalitions that fall outside the natural span of control establishes the frame of reference for the model acting as a stability barometer. In the final part of the chapter, an explanation of how extending the model provides users with modeling capabilities in multiple dimensions establishes the basis for the hypothetical vignette in Chapter III. Finally, Chapter II explains how changes in fervor and ideology change the nature of the map, benefiting some coalitions and harming others.

Chapter III, "Dynamics of the Model," uses the hypothetical country of *Doulah* to illustrate how the population map could be used throughout the evolution of an intrastate conflict. The scenario breaks down into three scenes: the first scene explains the underlying societal conditions and dynamics that lead to the conflict; the second scene is the mobilization of an insurgency against the state; finally, in the third scene, the chapter concludes by offering examples of a few potential outcomes.

Chapter III builds upon the rudimentary theories outlined in Chapter II, and demonstrates the objective mathematical model when realized as a population map of a state. The chapter uses well-established, though largely qualitative, principles of social movement and coalition politics to develop and translate the theory into an objective model that captures the dynamics at play. The vignette uses simple examples to relate the model to political, military, and diplomatic readers (the appendices provide complete mathematical explanation of the model). At the end of Chapter III, the reader will understand the working concept of the population map based upon issues within a population. The reader will further appreciate how different issues generalize and form a three dimensional map that charts population densities according to positions on given issues.

Chapter IV, "Conclusion and Recommendations," outlines the author's conclusions and recommendation on the utilization of the proposed population map. The

authors also provide recommendations on how future endeavors should be pursued to strengthen the model's outputs and areas to which the proposed population map may be addressed.

C.   THE ROOTS OF INTRASTATE CONFLICT: ISSUES THAT MATTER

This thesis seeks to develop a mathematical model that explains what a population looks like when graphed, similar to the way cartography maps perturbations on the ground. Why should someone seek to map a population's characteristics like terrain? Who could possibly use a population map, and to what end? These are valid questions, and their answers develop over the course of the thesis. More important are the methods of getting to the answers.

Revolution, a specific subset of *intrastate conflict*, is a contentious term that invites a wide variety of definitions and theories. Social contingency theory argues that revolution is the exception, not the rule.[5] Hobbesian thought argues that social coherence is the product of coercion, and a loss of coercion equals social unrest.[6] Contingency theory, on the other hand, appears to have fewer incongruities and its groupings explain social situations better.[7] Albert K. Cohen recommends four categories of revolution: (1) actor-oriented theories, (2) structural theories, (3) conjunction theories, and (4) process theories.[8] We posit that revolutions have elements of each group within them. However, the primary groups that drive our population map are conjunction theory[9] and process theory[10]. First, this thesis explains intrastate conflict in the context of conjunction theory because it accepts the most applicable elements of actor-oriented theory and structure

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[5] Johnson, *Revolutionary Change*, 169.

[6] Johnson, *Revolutionary Change*, 169.

[7] Johnson, *Revolutionary Change*, 170.

[8] Albert Kircidel Cohen, *Deviance and Control* (Englewood Cliffs: Prentice-Hall, 1966), 41–47.

[9] Johnson, *Revolutionary Change*, 178–179. Conjunction theory combines actor-oriented and structural theories of revolutions and constitute the mainstream of research. This theory places revolutions as a subset of social movements. Conjunction theorists seek to understand the origins of social movements, their ideology, structure, recruitment, and life cycle.

[10] Johnson, *Revolutionary Change*, 185. Process theory emphasizes the notion of contingency. New information and situations develop continuously, and an outcome can never be predicted simply on the basis of an explanation of a movement's origin. The contingency process attempts to mirror the full complexity of the real world and how events unfold.

theory (these aid us in defining our terms *fervor* and *ideology*). Second, process theory, most appropriately explains how one can use the model to identify the trends of a questionable society (covered in depth in Chapter III).

1. Defining and Categorizing Intrastate Conflict

In the period between 1945 and 2007 there were approximately 241 conflicts across the globe that fall under the spectrum of *interstate*, n*on-state*, i*ntrastate*, and e*xtra-state* wars.[11] Since 1945 the frequency of conflict has been on the rise and of the inclusive conflicts, approximately 70% of them were intrastate conflicts.[12] According to Sarkees and Wayman, intrastate wars are, "sustained combat between or among armed forces that takes place within territorial boundaries of a state system member and leads to 1,000 battle related deaths annually."[13] Specifically, this classification of conflict includes subcategories of conflict such as civil war, regional war, or inter-communal war.[14] Since internal conflicts are rampant in the current global environment, states' ability to negotiating peace is contingent upon their ability to objectively depict each stakeholder's strategic position.

All United States involvement in intrastate conflict since 1945 has been in response to the civil war category.[15] Distinctive to civil wars is the prerequisite that the national government responsible for the territorial boundary is one of the warring parties and that the opposition is an internal insurgent force capable of effective resistance.[16]

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[11] Meredith R. Sarkees and Frank W. Wayman, *Resort to War: A Data Guide to Inter-state, Extra-state, Intrastate, and Non-state Wars*, 1816 – 2007 (Washington, D.C.: CQ Press, 2010).

[12] Correlates of War, "Correlates of War v. 4.0, 1816–2007," accessed February 2, 2013 http://www.correlatesofwar.org/

[13] Sarkees, *Resort to War*, 64.

[14] Sarkees, *Resort to War*, 64.

[15] "Correlates of War."

[16] Sarkees, *Resort to War*, 66. "Effective Resistance has two necessary conditions: 1) both sides re initially organized for violent conflict; 2) the weaker side is able to inflict at least 5% of the number of fatalities it sustains."

Most relevant to the classification of civil wars are the motives and objectives of the insurgent force that seeks to overthrow the central governing authority or to resolve a regional interest.[17]

Regional interests are founded on the intention to secede from a specified territory, see the replacement of the government by a more befitting regime, or to redress abuses experienced by a geographic district.[18] The objectives over the course of the conflict evolve. As the objectives change, they adapt based on the transformation of the insurgent coalition. The insurgency's strength is relative to the power of its constituent groups, and its ability to provide a valid representation of violence for the cause.[19] Intrastate conflict is a complex compilation of violent internal struggles that take on a variety of forms that manifest as acts of politicide, genocide, military coups, armed secessionist movements, and religious or ethnic related contention.[20] The persistence of intrastate warfare continues to engage the United States in the affairs of other nations, and understanding who to help is critical.

Most internal conflicts result from a combination of multiple factors that lead to a breakdown in discourse between society and the state. Grievances (violation of norms) and greed (payoffs or gains) substantiate the root causes of insurgency and its objectives.[21] This research focuses on those factors most relevant to the relationship between the society and the central government that lead to the greed and grievances worth risking life and livelihood.

Providing essential services, protection from internal and external threats, managing law and order amongst the populace, and providing economic opportunity to support the welfare of individuals marks the social contract. A social contract exists between citizens and their governments that bind them together. A state is in *equilibrium*

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[17] Sarkees, *Resort to War*, 67.

[18] Sarkees, *Resort to War*, 67.

[19] Sarkees, *Resort to War*, 68.

[20] Barbara Harff. "No Lessons Learned from the Holocaust? Assessing Risks of Genocide and Political Mass Murder since 1955," *American Political Science Review* 97 (2003): 57–73.

[21] Bruce Gilley, *The Right to Rule: How States Win and Lose Legitimacy* (New York: Columbia University Press, 2009), 159.

when there is a mutually supportive and beneficial relationship between society and the government.[22] Grievances find their origin in the context of the social contract, and form the basis for the condition of *disequilibrium*. Finally, illegitimate acts against the people weaken the social contract, notably by the abuse of power and authority. Covered in Chapter III, the hypothetical country of *Doulah* provides the model with a contextual foundation. The model assumes that *Doulah's* society is out of equilibrium, and the government has a monopoly over the gains while the society at large suffers the grievances.[23]

Natural and *artificial control*s govern equilibrium within a society.[24] When the government uses a form of payment to buy allegiance or force to control the populace it exerts *artificial control* to maintain equilibrium between the society and the authority of the state.[25] Indeed, when the populace recognizes the government's legitimate rule and complies with its authority, the system has a high degree of *natural control*.[26]

Illegitimate actions and policies create disequilibrium between the government and the people. Disequilibrium in societies results from a lack of confidence in the government, and sets the conditions for insurgent coalitions to rebel against the status quo. In response, the government compensates for the diminishing compliance of the populace to maintain order by exercising artificial control. Exerting artificial control, the state seeks to regain the lost equilibrium between the state and society.[27] However, the use of side payments or force is not necessarily mandatory to regain equilibrium; rather sufficient government reform could accomplish the same feat.

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[22] Johnson, *Revolutionary Change*, 83–90. If the society and government are experiencing disequilibrium then organized violence may be a revolution, a sign of social movements or other collectives challenging the authority of the state. As Johnson stated, the causes of disequilibrium are the failures of the homeostatic mechanisms to work, the product of sudden, intense, unprecedented pressure that incapacitates the system's ability to self-regulate by way of institutional procedures and mechanisms to maintain equilibrium.

[23] Johnson, *Revolutionary Change*, 83–90.

[24] Gordon H. McCormick, "Seminar in Guerrilla Warfare," class notes for DA3802, Naval Postgraduate School, Winter 2012.

[25] McCormick, "Seminar in Guerrilla Warfare."

[26] McCormick, "Seminar in Guerrilla Warfare."

[27] McCormick, "Seminar in Guerrilla Warfare."

According to Johnson, the process of conservative change gives the government the ability to restore equilibrium by making political concessions or resolving public grievances.[28] Representative forms of government attempt to appease the public in order to maintain influence and legitimacy. Less representative forms of government use a higher degree of artificial control measures, mainly in for form of force, to pacify dissenting populations. States can rectify disequilibrium by correcting departure from the status quo or by identifying the new socio-political preferences within the society and influencing expectations and fervor. Failure to understand the socio-political preferences can lead to a country with revolutionary potential.

Revolutionary potential is when a society falls into disequilibrium where the government no longer represents the social mores of the society.[29] Likewise, the population map assumes that natural and artificial controls are phenomena that allow a government to maintain its position as the head of the state.

As the revolutionary potential in a country increases, the level of natural control a government has over the population decreases; hence, the amount of artificial control must be elevated to compensate for the void in the control apparatus. Leites and Wolf suggest the government's overuse of artificial control mechanisms ultimately lead to diminishing returns for the state and launch society past the range of normal politics into tumultuous violence. When disequilibrium exceeds the capabilities of natural and artificial control to bring the relationship into balance, and a viable coalition has exceeded the range of normal politics, the government becomes less and less able to reform quickly enough to bring the state back into equilibrium. Defining moments such as exceeding the range of normal politics generally mark the beginning of a revolution.

Germany had a long slow revolutionary slide. Prior to World War I the Austria-Hungary Empire state was having a difficult time retaining the elements of natural and artificial control. Seeking to "Slavize" Austria-Hungary, disaffected youth rebelled at the

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[28] Johnson, *Revolutionary Change*, 60, 90. Separate with a comma; find and fix all similar.

[29] Johnson, *Revolutionary Change*, 83–90.

thought of assimilating Slavs into their society.[30]   When Gavrilo Princip—a Bosnian Serb—assassinated Archduke Francis Ferdinand in 1914, Adolf Hitler—then in his mid-twenties, initially worried that German students had shot the Duke in order to free the German people from Ferdinand's desire to assimilate Slavs with Germans.[31]   Hitler understood the tensions rising within German society. He anticipated such tenuous circumstances would lead to a climactic end if not defused. He seemed to have a working population map in his mind. Unitary rational actors can manipulate society without a population map when that society is in disequilibrium. Democracies and international actors/coalitions need a more substantial model. The following quote from *Mein Kamphf* highlights Hitler's comprehension.

> …the Balkans were immersed in that livid sultriness which customarily announces the hurricane, and from time to time a beam of brighter light flared up, only to vanish again in the spectral darkness. But then came the Balkan War and with it the first gust of wind swept across a Europe grown nervous. The time which now followed lay on the chests of men like a heavy nightmare, sultry as feverish tropic heat, so that due to constant anxiety the sense of approaching catastrophe turned at long last to longing: let Heaven at last give free rein to the fate which could no longer be thwarted. And then the first mighty lightning flash struck the earth; the storm was unleashed and with the thunder of Heaven there mingled the roar of the World War batteries.[32]

The disequilibrium that caused the First World War was not resolved during the interwar period, and the result was the Second World War.

The duration of disequilibrium and the measure of artificial control directly relates to the amount of revolutionary potential within the state. Hitler felt the potential within Germany prior to World War I, and embraced the feeling during the interwar period.[33]   According to Chalmers Johnson, an examination of violence in society explains revolutionary potential. Johnson suggests that criminal, rather than

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[30] Adolf Hitler, *Mein Kampf* (Boston: Houghton Mifflin, 1943), 158–159.

[31] Hitler, *Mein Kampf*, 158–159.

[32] Hitler, *Mein Kampf*, 158.

[33] Hitler, *Mein Kampf*, 158 & 373. On page 373, Hitler outlines the need for a new philosophy. He introduced the twenty-five theses of the Nazi party's new program to a crowd of nearly two thousand. Hitler understood how tenor and undercurrent within the society drive revolutionary potential.

revolutionary, acts of violence mark equilibrated states.[34]   Contrarily, revolutionary violence is the mark of a state in disequilibrium, which challenges the authority of the state—as evidenced by the Nazi party in the interwar period.[35]   A strengthened social contract between the populace and its government strengthens the fabric of society.

In order to categorize disequilibrium, Johnson presents a fourfold typology for the causes of disequilibrium: exogenous and endogenous value changing causes (e.g., intervention by Christian missionaries, communist parties, etc.) and endogenous and exogenous environment changing forces (e.g., technological innovation or increased medical capabilities).[36] In the context of preference and fervor these four categories lead to evolutionary preference changes.

All four categories are equally sensitive to disequilibrium, however the swiftness of assimilation into the culture and government determine the degree of *power deflation*, or loss of authority, for the government and thus the likelihood of revolution.[37]   These hypotheses explain the onset of internal violence toward a government. The exogenous and endogenous incongruities in value and environment affect the sociocultural, economic, and political realms of society, and illustrate society's disposition as fluid and noncontiguous.[38]   They help form the identity, attitudes, and perception of a population, and justify its actions.

Grievances play an important role in understanding what fuels collective action against a state authority, the basis of the collective narrative, and the strategic objectives that they generate. Grievances are dynamic and idiosyncratic, and form the general outline of the population base from which the movement derives its key characteristics

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[34] Johnson, *Revolutionary Change*, 62.

[35] Peter H. Merkl, *The Making of a Stormtrooper*, (Princeton: Princeton University Press, 1980), 31. While Germany maintained a monopoly of force during the 1920s and 30s it failed repeatedly to suppress private armies, including the SA—the Nazi Stormtroopers that would later become the SS.

[36] Johnson, *Revolutionary Change*, 72.

[37] Johnson, *Revolutionary Change*, 33, 72.

[38] Johnson, *Revolutionary Change*, 72.

and support. Sociocultural, economic, and political grievances form the ideologies, attitudes, perceptions, and justify the actions of a resisting population.[39]

Disparate, sometimes desperate, conditions experienced by varying groups within society build resentment toward privileged sects of society. The disaffected hold the government culpable for condoning or endorsing the status quo. These inequalities heighten the revolutionary potential of the populace, and tend to fall along demographic fault lines.[40]

Demographic groups mobilize easily due to their strong sociocultural association and common victimization. Ted Gurr concluded in *Minorities at Risk* that the drivers for political grievances of minorities stems from communal disadvantages that lead to demands for an increase in political rights and economic opportunities.[41]   Furthermore, political grievances related to the social contract because of government corruption, illegitimate political practices, or repressive policies that incite insurrection where the means and opportunity exist.

Nineteenth century theorists Karl Marx and Frederick Engels, best known for their *Communist Manifesto* (1848), highlighted that organization and classes interact to create a key element to revolutionary movements.[42] Marx and Engels asserted that, "[the Communists are] the most advanced and resolute section of the working class…that section that pushes forward all others."[43] They alluded to how the interaction between economic and political conditions and depravity merge to drive a working class resistance to the upper class and place elites in control of the government. The *Manifesto*'s contribution to revolutionary theory is the understanding of how the economic and political dimensions unite to create a powerful catalyst that drives organizing the masses

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[39] Ted R. Gurr, *Minorities at Risk: A Global View of Ethnopolitical Conflicts* (Washington, D.C.: United States Institute of Peace Press, 1993), 75–86.

[40] Frances Stewart, "Root Causes of Violent Conflict in Developing Countries," *British Medical Journal* 324, no. 7333 (2002): 342–343.

[41] Ted R. Gurr, *Minorities at Risk: A Global View of Ethnopolitical Conflicts*, 86.

[42] Farrokh Moshiri, "Revolutionary Conflict Theory," in *Revolutions of the Late Twentieth Century*, eds. Jack A. Goldstone, Tedd R. Gurr, and Farrokh Moshiri (Boulder, CO: Westview Press, 1991), 10.

[43] Karl Marx and Frederick Engels, *The Communist Manifesto* (London: The Electric Book Company, 1998), 27.

along these two lines. Although they wrote the *Manifesto* over 160 years ago, it still has relevance—notably in the developing world, and where communist ideology still surfaces to challenge capitalism and modernization.

Greed can be a powerful motivator for the insurgent to support the movement when grievance is insufficient to garner support, or when greed fails to inspire citizens to engage in risky behavior. The concepts of greed and grievance are not mutually exclusive.[44] Grievance is more likely to be paraded as the narrative of a revolution rather than the incentive for financial outcomes in the interest of public perception.[45] Where greed is the primary motivation for insurgent leadership and guerillas to fight the most powerful and relatable grievances will be utilized for propaganda purposes.[46] Additionally, the groups that comprise an organization challenging the authority of the state retain multifarious motivations and cost-benefit calculus to determine when and when not to fight. Therefore, it is reasonable to assume that groups are comprised of people who fight for a variety of reasons, most of which will fall under the motivational categories of greed or grievance.

Paul Collier's research found that economic agendas were central to determining risk factors that indicate the likelihood of civil war.[47] He argues that economic incentives and opportunity are more likely to be the primary motivators to engage in violent civil conflict.[48]

Greed motivation solves the free-rider dilemma.[49] Free-riders remain loyal to the government, or occupy a position of neutrality even though they are ideologically aligned with the insurgency, but they seek to benefit from the rebellion without incurring the cost of action. McCormick and Giordano explain the primary challenge of the insurgency is to

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[44] Paul Collier, "Doing Well Out of War: An Economic Perspective," Conference on Economic Agendas in Civil Wars, (London: The World Bank, 1999), 92.

[45] Collier, "Doing Well Out of War," 92.

[46] Collier, "Doing Well Out of War," 92.

[47]. Collier, "Doing Well Out of War," 91.

[48] Collier, "Doing Well Out of War," 91.

[49] Collier, "Doing Well Out of War," 98–99.

gain enough recruitment to attract membership. Furthermore, they propose that the mobilization paradox, as it were, can be overcome through the use of symbolic violence or the use of side payments.[50]

Civil wars create financial opportunities during times of conflict, which encourage the motivation to fight as part of the insurgency. The creation of financial opportunity is especially prominent in populations with high unemployment and a youth bulge.[51] The discovery of new markets and illicit activities for funding may help to perpetuate the war against the state.[52] Greed has strong empirical validation attesting to the role that it plays in recruiting insurgents.

Disequilibrium creates revolutionary potential in a society and is responsible for the greed and grievance that motivates the recruitment and sympathetic support for social movements. It is the dynamic interplay between motivation and conditions that generate strategic objectives. The strategic objectives of revolutionaries seek to address the conditions that led to the grievances of the movement. Conversely, the state generally fails to identify strategic objectives that seek to rectify the revolutionaries' grievances. The antithetic viewpoints lead to war when the revolution can overcome the mobilization paradox.

Finally, since the primary objectives sought by insurgencies of the twentieth century aim to overthrow or modify the government, seek territorial secession to resolve sociocultural (religious fundamentalism, identity, ethnicity) issues, evoke the withdrawal of an occupying or foreign power, or to force modernization and economic reform, there will continue to be revolution as long as nation states fall out of equilibrium with their societies.[53] The perpetual nature of this cycle demonstrates that an evolving society must have a flexible government to adapt to the changing needs of its people, failing flexibility governments will ultimately fall. Population mapping gives democracies the flexibility

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[50] Gordon H. McCormick and Frank Giordano, "Things Come Together: Symbolic Violence and Guerrilla Mobilisation," *Third World Quarterly* 28, no. 2 (2007): 306, 311.

[51] Collier, "Doing Well Out of War," 110.

[52] Collier, "Doing Well Out of War," 110.

[53] Chuck Crossett, *Casebook on Insurgency and Revolutionary Warfare Volume II*: 1962–2009, ed. Chuck Crossett (Fort Bragg: United States Army Special Operations Command, 2012), vii.

they need to meet the ever changing needs of society without appearing weak, simply because the government can anticipate movement and reform when appropriate to maintain a healthy amount of natural control, which is the exemplar of good governance.

2. Third-party Intervention in Intrastate Conflicts

In Regan's study of third-party intervention, he typifies intrastate conflict as ethnic, religious, or ideologically based, with emphasis on three options for intervention categorized as military, economic, or a combination of the two.[54] There are two options available to an intervening party, to support either the central government or the insurgent opposition.[55] These two options typify conjunction theory. Namely, the intervening party's decision is based largely upon the structural environment of the conflict (i.e. Which side best serves U.S. and international interests?) and the specific power brokers that can influence the fervor within the population.

The optimal, and most likely goal of the interventionist, is to bring about the cessation of hostilities to achieve one or more of the following objectives: protecting the intervener's national interests (security, economic, political, etc.); defending human rights; support of a common ideology; territorial acquisition; or regional stability.[56] A successful third-party intervention strategy aims to modify the cost-benefit analysis of the belligerents by making the rewards for cooperation, compromise, and cessation of hostilities attractive or the cost of continuing the conflict prohibitively high.[57] Intervening actors who address the fundamental grievances of intrastate conflict by influencing fervor successfully deescalate the conflict without undue violence. The most successful interventions are those that are multifaceted providing military and economic aid to the government of the state.[58] The implications of Regan's research of third-party

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[54] Patrick M. Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," The Journal of Conflict Resolution 40, no. 2 (1996), 336–359.

[55] Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," 340.

[56] Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," 341.

[57] Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," 341.

[58] Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," 345.

intervention suggests that the most important factor predicting the probability of successful conflict resolution or a cease fire is dependent upon the interventionist strategy implemented.[59]

D.   ISSUES IN SOCIETY

The use of historical vignettes and theoretical analysis define the model's inputs, known as *ideology* and *fervor*. Hitler's rise to power in Germany during the interwar period provides the reader with a vibrant understanding of how a relatively small number of power brokers can influence *fervor*. Warfare in the information age is not purely a military struggle. Military leaders must understand statesmanship and be able to work as effectively in the political environment as they can wield the elements of military firepower. Likewise, political leaders and diplomats must see the strategic map differently than during previous epochs, and their vision must align with military leaders'. Political and diplomatic maneuver in combat zones, which falls on the shoulders of both military and civilian decision makers, is paramount to success.[60]

1.   Ideology

This work uses *ideology* to describe how one associates with a given issue. On any issue, one can back, oppose, or hold a moderate position.

Take, for example, the issue of a free market economy. Over the last century, the constituents of modern and developing nations have had strong opinions regarding a free market economy. At the extreme end of the spectrum, some people put complete trust into Adam Smith's invisible hand, assuming that the forces of the marketplace will always produce superior outcomes to the plans devised by the figures of authority.[61] On

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[59] Regan, "Conditions of Successful Third-Party Intervention in Intrastate Conflicts," 349.

[60] Adams, *U.S. Special Operations Forces in Action: The Challenge of Unconventional Warfare*, 147.

[61] Adam Smith, *The Wealth of Nations* (East Rutherford: Viking Penguin, 1776). Smith defines the invisible hand in his quintessential work. Note that we do not argue that Smith would prefer an entirely unregulated economy.

the other extreme, some people oppose the free market, preferring command driven solutions. The overwhelming majority of people prefer an outcome somewhere in between.

To demonstrate ideology, first consider an arbitrary scale ranging from negative one to one. The scale becomes the objective rating for an individual issue. Those holding the position of one fully support the issue, while those holding the position of negative one completely oppose it. Respondents holding the position of zero are indifferent. For example, people who support an entirely unregulated economy identify with the free market issue intimately. Hence, they rate a one. Conversely, a person diametrically opposed scores at negative one. Those who believe the government plays a limited role are more likely to be around zero.

Two important points bear mentioning. First, the scale allows a spectrum of answers. For instance, consider Alice and Bob. Alice largely supports a free market economy with a few caveats and reservations. She rates her ideology with the issue at 0.8. If Bob rates his ideology greater than 0.8, his support is definitively stronger than Alice's. If Bob rates his ideology at 0.4, he identifies with the issue half as much as Alice. If Bob rates his ideology as -0.8, then he ideologically opposes a free market economy as much as Alice supports one.

Second, Alice may identify completely with two separate issues, yet still prefer one over the other. For instance, consider a more trivial issue like receiving one hundred U.S. dollars. Alice rates her ideology for receiving the money at one. Similarly, she would rate receiving one hundred Mexican pesos at one as well. Alice independently supports both initiatives. However, she does not care about each issue the same. In this example, Alice prefers to receive U.S. dollars over pesos. The implication, when Alice faces a choice of one money (issue) over the other, is that she has greater passion for one; namely, her actual preferences require an assessment of her ideology with an issue and her fervency for the issue. Alice is passionate about accepting the dollars over the pesos.

2. Fervor

Fervor is a fleeting phenomenon. Fervor measures the passion a given person or coalition feels for one or more issues. As noted earlier, changing the ideology is not only difficult and time consuming, but nearly impossible in the short term without cataclysmic activity. Fervor is easier to affect, because it evokes an emotional response from the population in a two dimensional manner.

Positive fervor and *negative fervor* are the two aspects population mapping uses to depict a society's emotional response to issues. The two aspects seek the same result, but utilize different approaches. Positive fervor seeks to fuel ardor toward issues. Negative fervor seeks to agitate wroth towards selected issues. Positive and negative fervor are paramount to bringing issues to prominence, but in a complex society, they are not always enough. As in the many games of Game Theory, power brokers or coalitions seeking to change a *Nash Equilibrium* make threats or promises to draw coalitions into participation on an issue.[62] The physical manifestation of threat and promise is *obedience*, a component of artificial control.

Religions the world over instill love for their deity to amass a following. This work categorizes affectionate responses to an issue as *positive fervor*. Christianity, Islam, and Judaism demonstrate their love and commitment to God by daily worship. The use of ancient ceremony and sacred acts provide religious leaders with a congregation that follows the teachings of historic and present day leaders. A practitioner's devotion and sacrifice to his or her creator, prophets, and modern day leaders depicts how positive fervor is a powerful rallying force. Leaders and media affect fervor when their messages depict an existential threat to a particular population group's ideology. Jews throughout the world support Israel in the conflict over land between them and Palestine. Likewise, Muslims rally behind Palestine in the conflict. When outsiders threaten the founding principles of coalitions, positive fervor rises quickly for the cause, while negative fervor rises quickly against the adversary.

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[62] Avinash K. Dixit and Barry J. Nalebuff, *Thinking Strategically* (New York: W.W. Norton and Company, 1991), 76. "Nash Equilibrium is a combination of strategies in which each player's action is the best response to that of the other. Given what the other is doing, neither wants to change his own move."

Positive fervor discloses itself daily in secular and non-secular societies when social and economic issues raise the devotion of people to a cause. Hitler was adept at raising social issues to levels of contention that allowed positive and negative fervor to become relevant within the population. In 1935, Hitler used a powerful message to unite workers in Germany under his camp.[63] Hitler whipped the rhetoric in an oratory style that precluded the need for conscious thought, and raised the hackles on the disenfranchised and relatively depraved. In Nuremberg on September 12, 1936, Hitler spoke mainly with positive fervor to strengthen his position:

> There was sometimes advanced as an excuse for Russia that she had been through war and through revolution. Well, we stood against twenty-six States in the war and we had a revolution, but I have taken as my fundamental law not to destroy anything. Had I done so there would have been an excuse for rebuilding during another eighteen years.
>
> But that was not our plan. We wanted additional work for our unemployed and the use of the volume of their increased production to increase every man's share in consumption. Wages are not based on production; production itself is the wage.
>
> If I had wished I could have substituted officials for employers, but nature and reality select best. We do not wish bureaucratic economics as in Russia, nor do we wish to establish economic democracy here.
>
> Yet that does not mean either that we wish to let things drift as they please. Our fundamental economic principles are, first, to unite all the forces existing, and secondly, to educate our people better in their use.
>
> This Labor Front is the greatest element in such education. You are servants of the nation, but you alone are nothing. As part of the organic whole you are everything...
>
> It is hard to build up a new life out of your poverty, but I am not complaining. On the contrary, I find it wonderful to face difficult problems.[64]

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[63] Adolf Hitler, Nuremberg, Labor Front Speech September 12, 1936, Hitler Historical Museum, (© 1996–2012), accessed February 15, 2013, http://www.hitler.org/

[64] Adolf Hitler, Nuremberg, Labor Front Speech September 12, 1936, Hitler Historical Museum, (© 1996–2012), accessed February 15, 2013, http://www.hitler.org/

Notice how he rallies various classes of citizen to a unifying cause. The positive fervor garnered for his coalition speaks to the plight felt by many during that turbulent time. Hitler's strategic oratory style depicted him as the standard-bearer for an aggrieved polity.

Fear or hatred for another sect of society, leader, or movement (among other entities) is a polarizing power for differing coalitions within a society. This work classifies *negative fervor* as a derivation of agitation to generate animosity for an issue.

Rather than rallying members of populations to a unifying issue, negative fervor fractures a population by agitating coalition members against an issue. The effects are different from positive fervor. While positive fervor rallies or pulls together disparate groups around a unifying entity, negative fervor seeks to polarize coalitions against one another. This divisive effect has a distinct purpose: weakening a population by an issue with agitating rhetoric to manifest negative fervor is the fastest, but least enduring method of garnering support for the greater cause. Used in conjunction, the two aspects of fervor act in concert. On the one hand, negative fervor fractures an otherwise unified populace, while on the other hand positive fervor unifies the factions under a new banner with positive fervor for emerging power brokers.

An increase in fervor does not automatically mean a change in preference. The high school shooting that occurred on April 19, 1999 in Columbine Colorado incited a fierce gun control debate throughout the country.[65] Fervor is an interesting bedfellow. Within a week of the shooting, then President Bill Clinton introduced legislation banning private weapons sales at gun shows. Initially the senate rejected the bill, but after a weeklong debate in the public media, they passed the law. Fervor caused action, but since the senate ceded to a portion of the debate in the short term, long-term fervor fizzled. Consequently, the gun-show loophole legislation ultimately failed, and has never become an effective law.

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[65] David Olinger, "Massacre Energized Gun Debate—but not Lawmakers," *The Denver Post*, April 19, 2000, accessed on February 16, 2013, http://extras.denverpost.com/news/col0419g.htm

The bureaucratic nature of politics has two natural remedies for combatting contentious issues. Political concessions diffuse contentious, negative fervor for issues by assuaging perceived wrongs. While slow political processes release the pressure created by acute events and allow negative fervor to dissipate over time. The gun control debate following the Columbine shooting raged through the media and in homes immediately following the massacre, but legislation, which is inherently slow and not always effective, was largely able to resist the spike in fervor and prevent radical changes to the U.S. and state constitutions.[66]

Swift changes in fervor can force changes in preference, though not on the scale of complete reform. Preference changes occur incrementally and usually when drastic events cause a spike in fervor for a particular issue. Preference changes are not complete shifts in the short term; rather, fervor spikes that incrementally pull the constituency in a certain direction cause *ideological drift*, which is the evolutionary means that change societies preferences.

In the early half of the 20th century Germany underwent ideological drift on a national scale. Hitler and his close following were rallying point for Germany's ideological drift. The structural situation in Germany already existed; Hitler's adept use of positive and negative fervor was the vanguard to worldwide conflict.

In order to shape outcomes an actor identifies the goal of his or her organization. Understanding the political landscape is often a combination of multiple opinions shared amongst a collection of individuals seeking to affect the landscape. Hitler and his supporters in the National Socialist German Workers' Party (*Nationalsozialistische Deutsche Arbeiterpartie*—NSDAP) utilized their collective influence to raise Hitler's standing and ultimately seized his dictatorial supremacy by utilizing their knowledge of the population.[67]

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[66] David Olinger, "Massacre energized gun debate—but not lawmakers," *The Denver Post*, April 19, 2000, accessed on February 16, 2013, http://extras.denverpost.com/news/col0419g.htm

[67] Fest, Joachim C., *Hitler*, translation by Richard and Clara Winston (New York: Harcourt Brace Jovanovich, Inc., 1974), 123–147.

A figurehead that garners positive fervor to the first, second, and third standard deviations from a coalition center raises extends the natural control. The figurehead anthropomorphizes the issue. However, the figurehead rises to power on the backs of many supporters. Hitler was the figurehead for the NSDAP because of his apparent ubiquity with the working class and the machinations of the bourgeoisie society members seeking the supremacy of the NSDAP.[68]

Positive fervor is coupled with negative fervor to co-opt the remainder of people that do not fall under the banner of positive fervor for an issue. Rhetoric about an issue brings unaffiliated factions under the natural control of the coalition by allying the fears and hatred of one faction against another.

Hitler leveraged the opposing party members of the NDSAP against his own rising support.[69] His political acumen prevailed, placing the NDSAP opposition party members in a position that forced their capitulation to Hitler demands for dictatorial power.[70] Once aligned under a common figurehead, a certain degree of solidarity begins to coalesce thereby establishing the social movement. The dynamics between the proletariat and the bourgeoisie of German society in the 1920's exemplified the need for a figurehead. Furthermore, the factionalized nature of Germany saw a dynamic play out between two sects of German society: those hungry for authoritarian rule joined the NSDAP—the rising fascist dictatorship of the Nazi party—and supporters of the post-World War II camp that largely followed communist thought.[71] Hitler's own words shed light on the factions and unified them under one precept: "For a class-conscious worker there is no room in the NSDAP, any more than there is for a status-conscious bourgeois."[72]

How can insights from Hitler's use of population influence help democratic nations strategically implement population influence for good? Utilizing this work's

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[68] Fest, *Hitler*, 148.

[69] Fest, *Hitler*, 148.

[70] Fest, *Hitler*, 148.

[71] Fest, *Hitler*, 148.

[72] Fest, *Hitler*, 148.

model, the United States can portray populations in a manner that identifies revolutionary potential in geographic space and curtails manifestations of violence and disorder by linking social, economic, political, and cultural grievances to instability. Finally, by acknowledging and understanding precursors to violence and disorder, the United States can effectively and positively influence population groups by addressing the root causes of revolutionary potential within a country.

E.   SOCIAL MOVEMENT

1.   Changing Ideology

This research suggests that personal ideology changes over time, but it takes many decades because it evolves as a person matures. Ideology works on a generational scale, rather than monthly, weekly, or annually.

Studies allude to changes in ideology by investigating the roots of normative changes in society. From an anthropological point of view, Fredrik Barth has detailed the generational process through which norms and values might change in society.[73]   His work describes the boundaries imposed by a functioning society. Society's boundaries clearly delineate acceptable values from forbidden desires. In the present, structural limitations are inflexible since a departure from the norm ruptures the fabric of the society imposing the value. As the society evolves through generations and epochs, so evolve the norms. It is a slow and careful process. As we consider ideology, one can think of subcultures within a society in order to apply Barth's model.

Contemporary society has found room for a variety of social ideologies to coexist. Yet, the development of ideology relies upon the same boundaries and expectations as described by Barth within partitions of society. Whether in the Third World or the First, individuals have families, friends, cliques, and institutions that set the boundaries and expectations for their ideology. Thus, political persuasions and ideology stem directly

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[73] Barth, Fredrik, "Boundaries and connections: Signifying identities," *Anthropological Perspectives on Boundaries and Contested Values* (2000), 17–36.

from environmental considerations.[74]   Globalization begs the question: is the old paradigm still relevant? In other words, are people still ideologically bound in a world where digital networks span the remote corners of the earth? The answer is yes. In fact, several studies indicate that the flourish of digital technology has only added to isolation within society.[75]   People of a given persuasion tend to use the vast array of communications networks to confirm their worldview. Digitally isolated circles serve to set new boundaries for acceptable ideology, much like societies in Barth's analysis. Simply put, once an individual forms an ideology, one should not expect it to change quickly or easily.

In *Preference Change: Approaches from Philosophy, Economics, and Psychology*, Till Grüne-Yanoff and Sven Ove Hansson compile the leading contemporary theories on preference change, which correlates to our definition of ideology. Implicit in their title, Grüne-Yanoff and Hansson consider a variety of disciplines from which to evaluate the phenomenon.[76]

This work, as an analysis of preference change, echoes two important points. First, preferences change slowly regarding the population at large. An individual may change his or her mind on a given issue due to errors in judgment. However, such events occur on the margin, implying that for every reformed socialist, one expects to find a repatriated capitalist. Second, it takes a significant investment to change an individual's preference. This makes sense, as one considers that ideologies evolve over a lifetime. However, when considered from a macro-level, Grüne-Yanoff's and Hansson's comprehensive analysis suggests that ideologies remain static.

Theories of slow ideological change mean nothing if the empirical record paints a different story. Perhaps World War II offers the best example for radically evolving

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[74] Jennifer Glass, Vern L. Bengtson, and Charlotte Chorn Dunham, "Attitude Similarity in Three-Generation Families: Socialization, Status Inheritance, or Reciprocal Influence?" *American Sociological Review* 51 (October, 1986): 685–698.

[75] M. McPherson, L. Smith-Lovin, and M.E. Brashears, "Social Isolation in America: Changes in Core Discussion Networks Over Two Decades," *American Sociological Review* 71, no. 3 (2006): 353–375.

[76] Till Grüne-Yanoff and Sven Ove Hansson, *Preference Change: Approaches from Philosophy, Economics, and Psychology* (New York: Springer, 2009), 2–22.

preference on the macro-level. The discovery of the Nazi concentration camps changed the heart of nations, especially among a population guilt-ridden over the idolatry of its Führer. Barth describes this phenomenon in his anthropological study. While ideology generally remains static, acts of cataclysmic violence can revolutionize societies from within or without.[77]   This work argues that the United States ought to prefer that preferences change slowly for the good of all.

2.   Changing Fervor

Unlike ideology, fervor can change overnight. On April 8, 1865, the Confederate and Union soldiers engaged each other in mortal combat on the fields surrounding Appomattox Courthouse. On April 9, they laid down their arms and reunited as countrymen based on an afternoon shared by Lieutenant General Ulysses S. Grant and General Robert E. Lee. Perhaps Grant captured the instantaneous de-escalation best when he ordered his men to stop cheering the defeat of their Confederate adversaries. Writing about the incident, Grant recalls, "I at once sent word…to have it stopped. The Confederates were now our countrymen, and we did not want to exult over their downfall."[78]

The meeting between Grant and Lee transformed a battle, where thousands of men would have fought one another, into a parade field. The relative peace can be attributed to fervor; both sides blood was up prior to the accord, but immediately following widespread exultation was felt over the end of hostilities.

An interesting point of fact contrasts ideology and fervor. The Confederate soldiers did not cease to celebrate and extol their Southern ideology. On the contrary, the longevity of the Confederate flag as a contemporary symbol of Southern pride confirms that many of the ideologies that existed prior to the Civil War continue to exist today. While ideology persists, the fervor changed with the simple act of putting ink to a document.

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[77] Barth, "Boundaries and connections: Signifying identities," 59–71.

[78] Jay Winik, *April 1865: The Month That Saved America* (Harper Collins, New York, 2006), 191.

F. CONCLUSION

Objectively depicting populations in a topographical fashion requires a new way of defining how passionate people feel on issues and how they personally identify with particular subjects. This chapter has explained that ideology is the way people at the micro level identify with social issues at the macro level. The passion people feel at the micro level translates into fervor at the macro level. Ideology and fervor provide are the two critical components necessary to characterize a society as either stable or unstable. Though ideology and fervor provide the necessary components to develop a preference surface that depicts the location of coalitions relative to one another, they are not existentially sufficient to determine stability. Integrating the level of natural and artificial control into the surface is a critical step to determining how disequilibriated a society remains. The next chapter explains the development of mapping societies.

II.   THE MODEL

A.   INTRODUCTION

Much as a geographic map offers a discrete and objective representation of physical terrain, a population map offers quantifiable insight into human terrain. The ideas and definitions from Chapter II provide the foundation for mathematically modeling the values of a constituency. For simplicity, this work uses hypothetical characters, 'Alice', and 'Paul'. Alice is from country 'A' and Paul is a pollster. Two additional countries, 'B' and 'C,' aid in describing the model and the process to the reader. The hypothetical population map offers a discreet look at the inner dynamics of a state. It analyzes constituents' values regarding issues with revolutionary potential in order to illustrate the dynamics of competing coalitions in times of war and peace.

The chapter uses the two aspects of population mapping, ideology (the shape of the preference curve) and fervor (the scale of the preference curve), in the context of the model. We explain how the model is an intuitive method of building the map in, "An Issue in One Dimension." Then, we explain how coalitions with similar ideologies naturally align in, "Span of Control." The next section introduces the concept of, "Assisted Preference," and how to co-opt coalitions that fall outside the natural span of control. Finally, we explain how, "Extending the Model," provides users with modeling capabilities in multiple dimensions.

We start by considering a hypothetical issue within a population that exists in one dimension. Assuming that we have data describing the issue through the use of survey data, subjective analysis, or a number of other tools, the hypothetical scenarios infer how the population feels about the issue under consideration. The hypothetical data produces a preference curve of the population based upon the constituents' ideology and fervor. Issues drive coalitions within populations and coalitions rely upon the support of people.

The model assumes that people will tend to support a coalition with which they agree. According to the population map, these constituents lay 'close' to the coalition.

This concept generalizes from a single issue (or dimension) to multiple issues (and hence, multiple dimensions with each issue yielding a new dimension on the population map).

A society may have dozens of issues that matter. Consider the United States, where many issues quickly emerge as relevant—free market economics, individual responsibility, foreign military intervention, abortion rights, separation of church and state, and so forth. Even though each of these issues presents its own possible dimension within the American constituency, they simplify into one dimension on the spectrum ranging from liberal to conservative.[79] In the United States, political science and decades of polling data has well established this reduction of the political space. For a general population, our population map uses linear algebra to simplify the issues that matter in a society without exhaustive subjective analysis and decades of data.

B.   AN ISSUE MODELED IN ONE DIMENSION

The issues within a society provide the cornerstone of the population map. The map depicts the degree to which the norms of a society agree.[80] Therefore, one must consider each of the issues that exist within a constituency. Tracing this process through one hypothetical issue illustrates the process.

Using the definition of issue from Chapter II, consider the citizens of fictional country 'A'. The country of A suffers bitter debate over embracing a free market economy within the society. Assume there are two extreme constituencies within A. One extreme seeks an entirely unregulated economy. The proponents of an unregulated economy believe the forces of the market will achieve optimal outcomes. The other extreme distrusts market forces and corporate greed. This group seeks to place the reigns of the economy entirely within the control of the government. Next, assume the camp opposing capitalism lays at negative one on the issue spectrum and the camp supporting it

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[79] A tradeoff clearly exists between accuracy and simplicity. For instance, many Americans hold socially liberal values and economically conservative (e.g., libertarians). This voting bloc does not fit nicely along a one dimensional spectrum. Fortunately, the mathematical methods give an objective measure of the error due to simplification for a population. See Appendix A for greater detail.

[80] Johnson, *Revolutionary Change*. For the purposes of this work, the concept of 'agreement' most closely resembles Johnson's equilibrium within government and society and between government and society. See chapter 4 for greater detail.

lays at positive one on the spectrum. A polling company now samples the society by inquiring about the constituents' feelings on the economic system. Polling companies in countries B and C conduct similar surveys. Compiling the results, they end up with density distributions of their populations—or at least estimates according to the accuracy of their sampling methods. Figure 2.1 depicts some hypothetical results from the process.
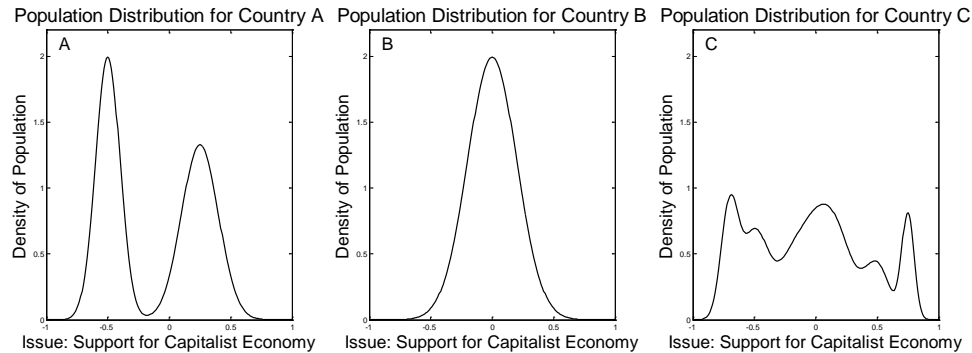
Figure 2.1   Three possible results from a population's preference survey according to its feelings on the issue "support for a capitalist economy."

The graphs depict three hypothetical results. Country A shows two distinct camps with little middle ground. Most people either hate the free market or they love it. The center graph in Figure 2.1 represents Country B, which depicts a typical response; namely the population in country B resembles a normal curve where the majority of the population holds a moderate value position. On the right of Figure 2.1, country C depicts a society with a nearly random distribution for its economic preference. In country C, no dominant position emerges.[81]

A strong postulate is that country B yields the most stable intrastate system, as long as the state positions itself over the population median. In other words, a government holding a neutral value (i.e., zero) along the spectrum easily enjoys the

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[81] Note that since these curves represent population densities, the area beneath each of the curves is equal to one, representing 100% of the population.

majority of the population's natural support. However, the population's ideology regarding an issue only yields the shape of the curve and the shape explains one side of the issue.

The other side requires the pollster to ask his respondents how fervent they feel about the issue in question. In the example above, consider a respondent, Alice, who opposes capitalism. Her view against capitalism falls near negative one on the spectrum of ideology. Simultaneously, she cares very little about the issue, and hence rates her personal fervor as zero. Due to her lack of fervor, Alice accepts a capitalist government that holds a position closer to one on the spectrum of ideology. In this scenario, Alice and the government maximize their structural distance from one another. However, the emotional distance is negligible and the issue does not preclude Alice from offering her natural support. On the contrary, if Alice feels extremely passionate about the issue of economics and rates her passion at ten, then the government holding a position of one on the spectrum of preference remains distant to Alice and her emotions drive her actions— so much so that she might consider violent rebellion as an acceptable course of action.

Alice alone does not determine the scale of the fervor. Instead, the mean of the entire population determines the scale. Returning to Figure 2.1, consider two populations that hold the preference of the population at left in country A. One of the populations has an extremely high level of fervor and scores an average of ten. The other population has very little fervor for the issue of capitalism and scores an average of two. Both populations share identical shapes the preference curve (i.e., they have the same ideology for the issue), but differences in fervor affect scale significantly. Figure 2.2 illustrates the concept. Both populations have the same ideology for the economic system, yet the left population (Figure 2.2 A) has more fervor. This changes the scale for the horizontal axis. It also implies that a coalition within the left population (Figure 2.2 A) will have a harder time recruiting broad-based support than a coalition within the right population (Figure 2.2 B).
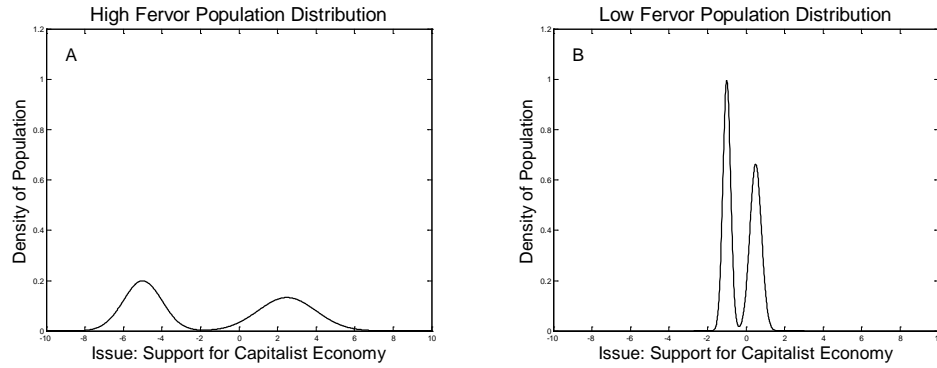
Figure 2.2: Two populations with the same ideology for the issue 'support for a capitalist economy'. The population on the left has high fervor while the population on the right has low fervor.

The methodology for mapping a population according to the issues within the society requires a quick defense for scaling fervor according to the population's mean fervor. Assume that Alice still prefers the command-driven economy (she scores near negative one on her ideology) and she has absolutely no fervor for the issue. If she lives among a fervent population (Figure 2.2 A), she regrettably finds herself among a society wrapped in a bitter—and potentially violent—contest over the free market al.ice prefers to live in a population less inclined to fight over such issues, such as the placated population (Figure 2.2 B). Denied this luxury, Alice must choose a coalition to support. Naturally, she chooses the coalition that most closely mirrors her ideology. Simply stated, individuals only choose the issues they support. The passion of the masses determines the scale of the issue.

The process of mapping an issue in one dimension yields a scaled preference curve of the population. The ideology regarding the issue determines the shape of the curve while the fervor determines the scale of the horizontal axis. Working with a single issue (or to put a fine point on it, a population map in one dimension), a conclusion regarding intrastate stability quickly emerges. *The linear distance from a constituent to a coalition directly relates to the propensity of the constituent to support the coalition.*

C.   THE SPAN OF CONTROL

Constituents yield natural control to governments that reflect and support the issues that matter to the constituency. Therefore, one can think of a government as having a position on the population map according to the issues that it supports. Constituents close to the governmental coalition support the coalition while those far from the coalition oppose it. The scale to which a constituent supports or opposes the state depends upon the distance between the two on the population map.[82] To generalize this concept, the population map model requires a few conventions.

First, if a coalition plants its flag at a position upon the population map, it enjoys the natural control of the population within a specific distance from its position.[83] For illustrative purposes, call the distance the, "span of control. Initially, assume that the span of control equals one. Returning to the hypothetical population map for country A, with its preference distribution for capitalism, envision a coalition that holds the ideological position of negative one-half (i.e., the coalition generally opposes capitalism). Using the same shape of the preference curve (i.e., the same ideology), as in previous examples and a span of control of one, Figure 2.3 displays the control that a coalition with this position can expect in a fervent society (2.3 a) and a placid society (2.3 b). The shaded region depicts a span of one from each side of the coalition's position (i.e., the span of control for the coalition holding the position of the flag). The fervent society has a mean fervor of ten, which scales the society's ideology and gives the coalition a position of negative five (negative one-half times ten) on the preference curve. Similarly, the placid society has a fervor of two, which gives the coalition a position of negative one (negative one-half times two). In the fervent society, the coalition enjoys the support of less than 35% of the population. The same coalition, in a society that holds low fervor for economics,

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[82] Guillermo Owen, and Bernard Grofman, "Two-Stage Electoral Competition in Two-Party Contests: Persistent Divergence of Party Positions," *SOC Choice Welfare*, 26 (2006): 547–569.

[83] In reality, it makes more sense to assume that each individual constituent will cede a proportion of their full support to the government based upon the distance between the individual and the government on the population map. Appendix A deals with this complication, but it offers little to the general understanding of the population map and hence it receives no discussion within the body of this work.

can control most of the population. Logically, it follows that coalitions will struggle to maintain broad-based support from constituents in fervent societies. Yet, support does not come exclusively from pure preference.
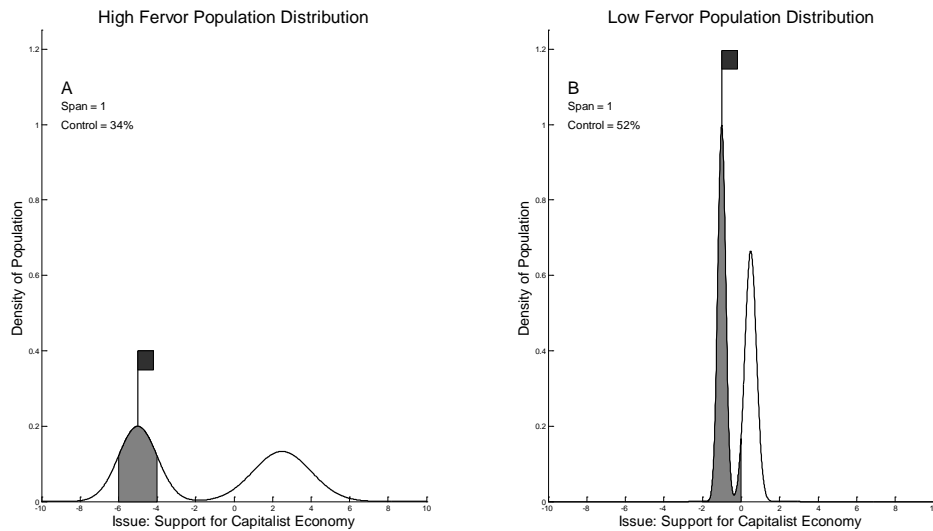
Figure 2.3   The span of control for the same coalition in a fervent and a placid society.

D.   ASSISTED PREFERENCE

Coalitions should prefer support from pure preference as it comes at no cost, but when pure preference eludes a coalition, it can always resort to obtaining assisted preference. A coalition can pursue assisted preference through a variety of methods.[84] Essentially, attempts to recruit support through assisted preference seek to manipulate the expected utility of constituents.[85] The population map provides insight into how the process works.

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[84] Nathan Leites and Charles Wolf, Jr., "Rebellion and Authority: An Analytic Essay on Insurgent Conflicts" Report Prepared for the Advanced Research Projects Agency, Santa Monica, CA: February 1970, 11–16.

[85] McCormick, "Seminar in Guerrilla Warfare." This work uses the utility calculations described by McCormick in order to demonstrate a constituent's decision to support a coalition.

First, consider the process by which an individual evaluates the utility in supporting a coalition. Gordon McCormick provides a straightforward model for the dynamics at play using expected values.

$$E(X) = P_B(X)B(X) - P_C(X)C(X)$$

In McCormick's equation, the expected utility in supporting coalition X equals the benefits of supporting X times the probability of receiving these benefits minus the costs of supporting X times the probability of incurring these costs.[86] Combining the utility equation to the population map carries implications for a coalition attempting to recruit assisted preference.

Clearly, individuals who hold positions close to the coalition on the population map benefit from supporting the coalition since they can expect it to promote their agenda.[87] Constituents who are positioned away from the coalition on the population map enjoy decreasing benefits and suffer increasing costs by supporting the coalition. For the current discussion, assume a 100% probability of incurring a cost or receiving a benefit and a linear relationship between distance in the population map and incentive (i.e., benefits and costs).[88] With these conventions, Figure 2.4 illustrates the relationship between distance from a coalition's position and the utility in supporting the coalition. At a distance of one (point B), the costs of supporting the coalition equal the benefits, so the net utility equals zero. Increasing distance beyond one results in a negative utility. The relationship suggests a cost to recruiting assisted preference from constituents outside of the coalition's span of control.

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[86] McCormick, "Seminar in Guerrilla Warfare." McCormick gives a detailed explanation of the dynamics at play in a population where two coalitions compete for control (i.e., the state and the insurgent). This work will presently focus on how the utility equation relates to the considerations of a single coalition attempting to recruit maximal control.

[87] Owen and Grofman, "Two-Stage Electoral Competition in Two-Party Contests: Persistent Divergence of Party Positions."

[88] McCormick, "Seminar in Guerrilla Warfare." In this sense, one can think of the probabilities in delivering benefits and exacting costs as strategic characteristics of the coalition in question (decisions made internal to a coalition). The current implementation of the population map focuses on structural characteristics of the environment (factors outside the coalition's immediate control). Thus, in the current discussion, assuming probabilities of one facilitates understanding of the population map.
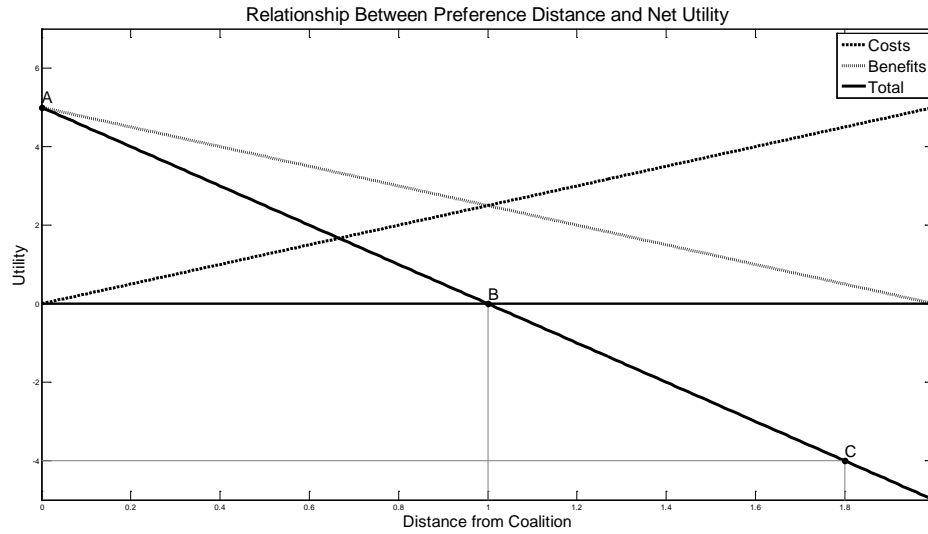
Figure 2.4   The relationship between utility for supporting a coalition and distance from the coalition on the population map.

Next, consider the coalition may employ resources to attempt to change the benefits and costs to supporting constituents. An efficient coalition expends resources to the point that the recruited population has a net positive utility. In Figure 2.4, this implies that constituents at a distance less than one offer the coalition natural support while constituents beyond one cost the coalition resources to recruit through assisted preference.[89]   Logically, it now follows that the span of control is equal to one in this society.[90]   While constituents prefer a coalition collocated with their position on the population map (point A), they will support any coalition that yields a net benefit (between point A and point B). Therefore, the span of control reaches the point where the utility of supporting a coalition equals zero.

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[89] McCormick, "Seminar in Guerrilla Warfare.". This assumes a simple contest between a coalition and constituents. In a case where competing coalitions exist (e.g., the state versus the insurgent), both coalitions may present a constituent with a positive utility. In this case, one would have to consider opportunity costs and the potential that some constituents may hedge their bets by supporting multiple coalitions.

[90] Note that this does not imply that the span of control is equal to one for all societies. The actual value for δ will depend upon the society. Furthermore, Chapter 4 will discuss ways in which a coalition might seek to alter this parameter.

Figure 2.4 illustrates another important concept in yielding support to coalitions. One can easily appreciate that conflict bears a price in any society.[91] If a coalition should choose to operate outside the realm of normal politics and resort to violent revolt and insurrection, it can expect hefty operating costs for financing this conflict. The horizontal line at negative four denotes the cost of conflict in this society (point C). Now, the net utility curve intersects the cost of conflict at a distance of 1.8 (the vertical line denoted on Figure 2.4). It follows that a rational citizen would consider resorting to conflict to oppose any coalition further than 1.8 from his or her position. On this population's map, the range of normal politics is 1.8. Beyond this distance, coalitions will resort to tactics outside the realm of the state's sanctioned political system.

E.   EXTENDING THE MODEL

Thus, far, the discussion of the population map has used one-dimensional illustrations. In most societies, multiple issues lead to the fissures within the social fabric that inspire the formulation of competing coalitions. The population map can accommodate any number of values in the same manner it handles one value. The appendices deal with the rigorous mathematics behind the model, yet anecdotal observations of American politics suffice to illustrate concepts without an understanding of the higher level math.

Consider Paul, a pollster attempting to capture the issues that divide America. He may pontificate about an expeditionary military, deficit spending, gun control, immigration law, and a countless litany of other issues that scroll across the ticker of the cable news shows on a daily basis. Paul wants to capture the essence of the American political space, and so he starts surveying the identity and the fervor of the American constituency according to each of these issues.

Initially, Paul surveys two issues, support for a woman's right to choose concerning abortion and support for amnesty in the immigration debate. He uses a survey

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[91] James Fearon, "Rationalist Explanations for War" *International Organization*, 49, no. 3 (1995): 379–384. This work borrows heavily from Fearon's concept of the cost of conflict, yet it simultaneously departs from his theories on the rationality of conflict. This work assumes that rational actors may elect to fight when the costs of submission exceeds the cost of conflict.

asking respondents to rate their ideology and fervor. Figure 2.5 displays Paul's responses on both issues. A woman's right to choose scores fervor of five, and marriage equality scores fervor of two. Notice that the graphs on the left depict a two dimensional response for a single issue, exactly like the graphs presented in Figure 2.2. These graphs show the preference densities for the two issues. The graph on the right presents a two-dimensional scatter plot of the two issues together, or the preference surface. For any given position on choice (the horizontal axis) and any given position on amnesty (the vertical axis), the population map depicts the density of the population supporting the given combination of the two views (high points—depicted in darker colors—represents higher concentrations of density, or peaks).
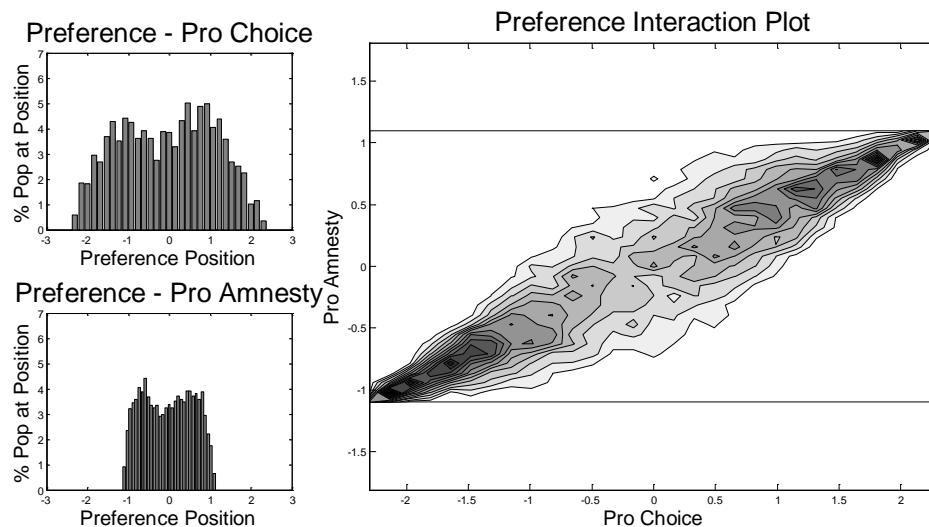
Figure 2.5   Preference curves for two issues in a society as well as a Preference Interaction plot, contour plot, of the interaction of the two issues.

Delving deeper into the American political psyche, Paul surveys another 14 issues. Now, he struggles to find an appropriate graphical representation of the shape of the preference surface in this 16-dimensional space.[92]   As Paul analyzes the data,

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[92] In a single dimension, one considers a preference curve. The issue of capitalism, as presented in this chapter, presents an illustration of a preference curve. As the model extends to multiple dimensions, one considers a preference surface.

searching for ways in which to depict the American polity, he begins to notice a trend: the same Americans who support strict gun control also tend to care less about deficit spending in lieu of economic investment. The same Americans who espouse immigration reform that offers amnesty generally favor limited military intervention abroad. After weeks of analysis, Paul realizes a single spectrum overwhelmingly captures the American constituency. Now, he can show the density of the American populace along a single axis—liberal to conservative. While Paul relied on observation and intuition to arrive at a subjective depiction of Americans as ranging from liberal to conservative, this work captures the same information on a population map using objective and quantifiable assessments.

Paul's research illustrates a common phenomenon in the politics of all societies. Myriad issues span a broad spectrum and tend to simplify into categories of ideology. For instance, a citizen who identifies as a social conservative tends to oppose amnesty for illegal immigrants, oppose legalized drugs, and support blending Judeo-Christian values into the public sector. A thorough examination of the American constituency will certainly find deviations from this trend, but generalizing a host of issues into the spectrum of social ideology captures the essence of the system with great accuracy. Paul spent many months collecting and analyzing survey data to prove what political scientists and decades of polling have already established in America. For less studied states, mathematical methods can use survey data to arrive at a similar—though culturally specific—conclusion without an army of analysts and decades of polling.

Formatting the survey data into a matrix allows linear algebra to simplify the data in a meaningful and expeditious manner. For instance, Paul takes each of his 16 issues as the columns in his data matrix, and the rows represent the individuals polled. Now, assume Paul surveyed 200 people. His data matrix has 200 rows and 16 columns. If Alice were the first person that Paul polled, then each of her responses for her ideology with the 16 issues would appear in the first row of the survey matrix. For instance, assume that Paul first asked about ideology regarding a free market economy and Alice rated her response as negative one (i.e., she completely opposes a free market on the original scale of -1 to 1). If the society's fervor for the issue were six, then Paul would place a negative

six in the first row of the first column, corresponding to Alice's scaled response, or her preference (again, preference equals an individual's ideological position multiplied by the society's mean fervor). Paul would repeat this process for every issue and every respondent.

Next, using principal component analysis (a technique of linear algebra), Paul dissects the data matrix into its principal components. In the American political spectrum, one imagines the space breaking down into two simplified axes, one spectrum of socially liberal to conservative people and one spectrum of economically liberal to conservative people. Again, because the American system has received so much scrutiny, these reductions come as no surprise. In a dynamic political system, in a remote corner of the earth, the linear algebra can solve this reduction with the right survey data. This work will break a polity down into the two primary spectrums of division based on the survey matrix in order to produce a topographical contour map, or our population map.

Reducing a multi-dimensional map serves a few purposes. First, a reduction to one or two dimensions allows a visual display, which enhances understanding. For instance, by simplifying 16 issues into the American political space into camps of liberal to conservative, Paul captures the driving factors in the political space without going into exhaustive detail on each of the 16 issues that he has surveyed. In this case, the simplification provides an accurate snapshot that one would miss in attempting to digest the data in its entirety.

Second, the reduction illustrates how changing the fervor or ideology for a single issue can manipulate the political space. If Paul employs his survey system in a poorly understood polity, he struggles to label the axes of the principal components (e.g., liberal to conservative). The method reduces any population into its most influential camps according to survey responses, but it does not explicitly define the nature of the camps. Fortunately, Paul's model provides insight into the primary divisions within the studied society by displaying the projection of an issue onto the population map. For instance, using the example of American politics again Paul analyzes gun control, and discovers its projection onto the population map. Figure 2.6 displays Paul's projection. Implicitly, a change in fervor or ideology regarding gun control moves the population along the

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direction that the issue appears on the population map. Therefore, the model takes as many dimensions as one cares to survey and simplifies them in order to depict a terrain map where the relief depicts the density of populations that subscribe to the position of the primary polarizing spectrum of issues (or the first principal component) and the secondary polarizing spectrum of issues (or the second principal component). It then depicts the effect that a change in any single issue will have on the overall structure of the population.
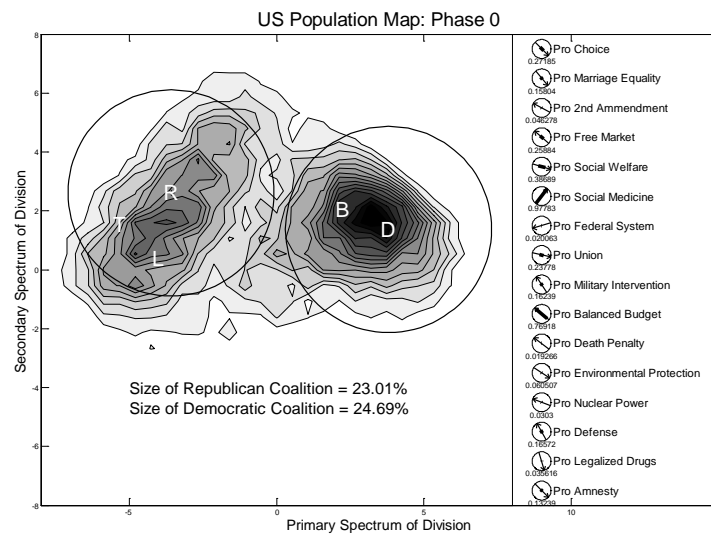
Figure 2.6   The projection of the issue of gun control onto the U.S. population map.

Chapter III uses this model in our hypothetical example to display its relevance in intrastate conflict. For now, consider a hypothetical example of the American constituency map depicted in Figure 2.6. The map depicts all of Paul's 16 issues on the right. Again, the arrows depict the direction in which the issues impact the map. The length of the weighted line and the number beneath each issue projection correspond to the effect that the issue has upon the map. A one would indicate that the issue completely dictates the distribution of the population along the population map in the direction depicted by the arrow. Conversely, a zero would indicate that the issue has no impact whatsoever upon the map. In Figure 2.6, two primary camps emerge. Notice, the

Democratic Party dominates the 'high ground' denoting the maximal population density around the peak on the right (denoted with a D). Meanwhile, the Republican Party seizes the peak on the left (denoted by the R). In this situation, the span of control—as determined by the utility curves depicted in Figure 2.4—assumes a value of two.[93] Therefore, the population residing within a distance of two from either party offers its natural political support to the adjacent coalition. Next, assume a value of seven for the range of normal politics (i.e., the cost of violent conflict is high in American society, so the population must face an extremely negative net utility before resorting to insurrection). Some other potential coalitions exist within the polity. The Blue Dog Democrats (denoted by the B) tend to hold liberal positions on economic issues and conservative values on social issues. The Libertarians (denoted by the L) are the exact inverse of the Blue Dog Democrats. Finally, the Tea Party (denoted by the T) holds extremely conservative values on all issues.

Given the span of control and the nature of the populations depicted, strategies emerge for both parties. For instance, the Democrats have a tighter distribution than the Republicans do, as denoted by the tight and tall peak around their platform. The Democrat's density distribution runs from generally northwest to southeast (i.e., the ridge along the hilltop generally runs in this direction). Party discipline can benefit the Democrats if they use issues that polarize the constituency around about the northeasterly running axis since they have unity in this direction. Conversely, they do not want to stretch the map in the northwesterly direction, since increasing fervor for issues that impact the map in this direction (as determined by the issue projections) could push the Blue Dog Democrats out of the Democrats span of natural control.

Finally, Figure 2.6 shows the proportion of the population that naturally supports each coalition given a span of control of two. The Republicans start with 23 percent of the population and the Democrats start with 24.7 percent.

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[93] Note that this span of control differs from the assumed value of one given in Figure 2.4. One should note that the span of control will be different for each society depending upon the utility curve of the society under question.

Notice that the issue of support for the Second Amendment impacts the map along the northwesterly direction. As discussed, stretching the map in this direction (which occurs by increasing fervor for issues that fall along this axis) could hurt the Democrats because their ridgeline runs in this direction. Conversely, the Republicans—though they have a more distributed base of support—have a northeasterly running ridgeline. Therefore, they can benefit from increasing fervor for the issue of the Second Amendment. Figure 2.7 depicts the same American polity with the exact same ideologies and exact same fervor for every issue except for the Second Amendment. When fervor increases from 0.4 to 4.4, the Blue Dog Democrats start rallying for their Second Amendment rights.[94] As a result, they get pushed outside the span of natural control of the Democrats. Stretching the map in this direction also moves some people out of the Republican span of control, but it hurts the Democrats worse due to the structural ideologies of the American population. Whereas the Democrats had a margin of 1.7 percent of the population prior to the increased in concerns over guns, they now only have a margin of 1.3 percent after losing support from some Blue Dog Democrats.

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[94] We use Blue Dog Democrat to refer to the United States' constituents who are economically liberal and socially conservative. Blue collar workers are frequently thought of as Blue Dog Democrats, such as West Virginia coal miners.

US Population Map: Phase 1

Size of Republican Coalition = 18.32%
Size of Democratic Coalition = 19.58%
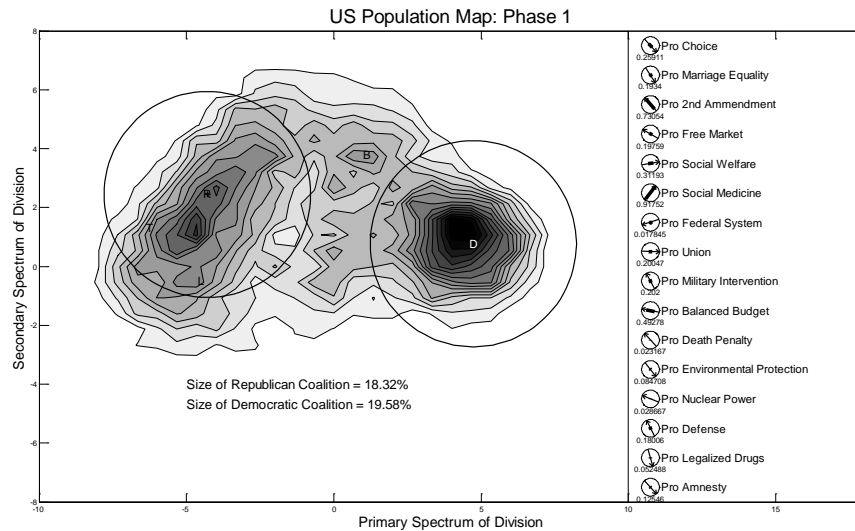
Figure 2.7   The U.S. population map with Republican and Democratic span of control indicated before and after an increase in fervor over the issue of gun control.

The Democrats have a clear counter to the Republicans' windfall gain in relative support. If they can increase fervor for issues that impact the map in a northeasterly direction, then they can fissure the Republican camp by isolating Libertarians and the Tea Party. Similarly, they should attempt to decrease fervor for issues that fall along the northwesterly direction in order to bring the Blue Dog Democrats back into their camp. Figure 2.8 depicts the American population map after fervor decreases for Second Amendment while increasing for social medicine. Here, they recoup support from the Blue Dog Democrats while splitting the Republican. Based on the ideologies driving the map, most members of the Republican camp enjoy benefits such as Medicare. However, the Tea Party and the Libertarians strongly oppose these programs, so increasing fervor for this issue leads to increased distance between these camps on the population map.
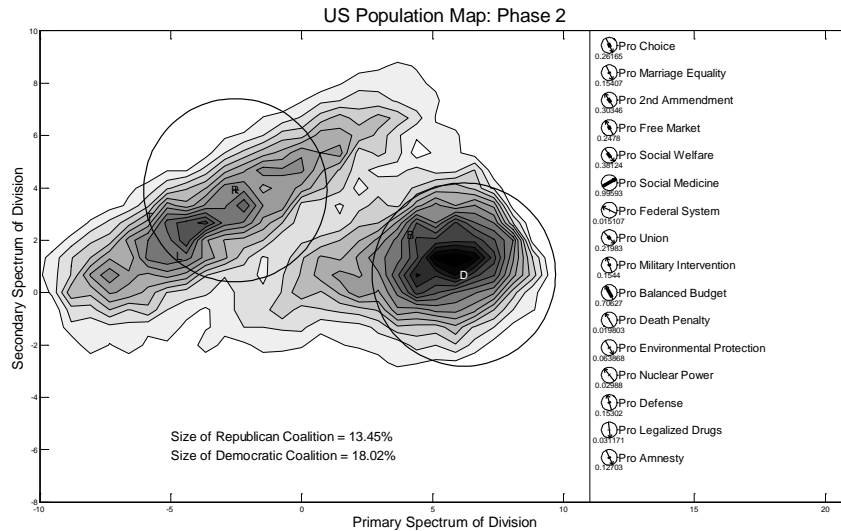
Figure 2.8   The U.S. population map with Republican and Democratic span of control for Phase 2 of gun control

In summary, the model is able to represent varied dimensions limited only by the analyst's or pollster's ability. Furthermore, it simplifies the dimensions in order to depict our population amp similar to a terrain map. The contour map depicts population density for the given, polarizing issues (or the first principal component). Concurrently, the map depicts the secondary polarizing spectrum of issues (or the second principal component). Finally, the population relief map depicts the effects that changes in any single issue have on the overall structure of the population. This population map offers insight into how to form and break coalitions through preferences and fervor. Moreover, it says a great deal about the stability or fragility of a state. For the nation engaged in a counterinsurgency fight, this model has significant implications for successful strategies when considering intrastate conflict as we shall illustrate in Chapter III.

III. THE WORKING MODEL

A. INTRODUCTION

In this chapter we explain the working dynamics of the model by following a chain of events that lead to a hypothetical government losing control over its population. Additionally, we explain how to use the model to develop strategy in order for the government to achieve Johnsonian equilibrium with the society and maintain its legitimate role as the governing body.[95] Specifically, we utilize three scenes that depict a hypothetical situation where a third party ultimately intervenes in a rebel's bid to gain control over its society after the ruling oligarchy has failed to quell rebellion and prevent revolution.

The three scenes describe one way rebellion evolves into of civil war. In the first two scenes incipient rebellion and revolution gain international visibility and demonstrate the evolution of society as fervor spikes for different issues. In scene three, the third party intervention scenario explains the application of the model to demonstrate how the United States can develop unique strategies for complex problems utilizing the population mapping tool. The chapter uses the terminology developed in Chapter I to shape the scenes. The model maps the population according to the methodology described in Chapter II. Beginning in Section B, the chapter describes a hypothetical country named *Doulah*. Tracing the evolution of *Doulah's* situation, the vignette explains the historic causes that lead to civil war from the context of the population map. With the background established, Section C develops the situation in *Doulah* as the situation devolves from a functioning government through the stages of intrastate conflict and culminates with a third party intervention. Finally, Section D contains results and conclusions from the vignette.

Each scene is a unique paradigm that explains the various elements of the population using the population map. Throughout each scene described in Section C, the fervor for issues changes within the society leading to the dissolution and forging of

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[95] Johnson, *Revolutionary Change*, 32& 72.

coalitions. As the passions for issues change, the ideologies of the constituents remain static. Therefore, all changes to the population map come only from changes in fervor. The scenes depict how actions within the polity manipulate fervor to the benefit of some coalitions and the detriment of others. Since all of the variables in the model, except fervor, are assumed to be static, the *Doulah* vignette acts as an archetype for population maps of real countries that are more dynamic systems. The relative simplicity of this prototype model enables the reader to understand the complex concepts by tracing the evolving population map in *Doulah*. Finally, to fully appreciate the dynamics of intrastate conflict and the difference between winning strategies and catastrophic follies with regard to population mapping, the reader should understand the preferences for the scenario are assumed based upon the personal and professional experiences of the authors.

B.   BACKGROUND

1.   History of *Doulah*

Doulah is a former French colony in the Middle East. The French granted it independence in the mid twentieth century, leaving a loyalist authoritarian regime composed of the *Aqleah* minority ethnicity. Under French colonial rule, vast oil reserves served French economic interests, which accounted for 40 percent of *Doulah's* gross national product. Following liberation, a brief period of private entrepreneurship led to elite business interests gaining control of the oil industry. The autocratic government acted quickly to nationalize the oil infrastructure in an attempt to maintain revenue. Over the last few decades, the government has failed to diversify the economy. The state has also developed a reputation for nepotism and corruption, which has discouraged foreign investment. The combination of these actions has led to a stagnating economy and a lack of development.

Doulah's population of 20 million has 34 percent *Aqleahs* and 66 percent *Aghlabeahs*, the two ethnicities in the country. It has a burgeoning youth bulge accounting for 37 percent of the population. The country's citizens are frustrated with the

18 percent unemployment rate. The average citizen has a high-school level education, and 35 percent of the population has some higher education. Such conditions make the government's position tenuous.

Doulah's state controlled media is losing clout in the information age. The private sector owns and controls communications architecture, but the state mandates limited access to foreign Internet sites and monitors domestic and international communications. The primary news outlet, a*l Khibra*, is semi-autonomous, but habitually echoes the message of the *Doulah* government.

The military is a cross section of the *Doulah* society, yet the *Aqleahs* overwhelmingly dominate the officer corps, which remains loyal to the government. The military presents a strong regional power modeled after the Soviets. It accounts for approximately three percent of the population, yielding a combined force of 600,000. An internal security force, *Shorta Khasa*, is responsible for rooting out political opposition to the government. This force is extremely loyal to the regime and reportedly uses forceful and coercive measures to enforce compliance.[96]

Growing economic ties to Asia have led to close relations with China and Russia. As a result, *Doulah* has grown increasingly independent of Western allies, to the point of intransigence on several key issues.

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[96] *Shorta Khasa* fills a vital, though ultimately paradoxical role in *Doulah*. On the one hand, the secret police element forces those individuals and coalitions that would otherwise be outside the realm of normal politics back under government obedience. On the other hand, once the threshold of governmental violence is crossed and the secret police begin to instill fear in the population, *Shorta Khasa* and *Doulah* are well on their way to revolution.

Agencies like *Shorta Khasa* prevent collective action by instilling fear throughout the population. The fear mechanism instills obedience, but it comes at a price; as the government continues the use of sanctioned violence against its people, the degree of disequilibrium increases. Ultimately, once the government crosses the threshold into civil violence against the populace, a vicious cycle begins that leads to revolution and civil war. Herein lays the paradox. The government cannot bring coalitions that are outside the realm of normal politics back into the spectrum of obedience without significant reform or by exercising violence upon said coalitions. However, when they inflict violence upon the same the vicious cycle results in revolution.

2.   Issues Facing *Doulah*

A polling company surveyed the population, and its initial findings revealed the five most relevant issues in the society: ethnic identity, equal protection, political representation, free market reform, and constitutional freedoms. Still, inherent inequalities exist within *Doulah* along social, economic, and political lines. The *Aghlabeahs* hold the ideological position that liberal reforms are necessary in order to increase social justice, economic opportunity, and access to the political system. These issues have not led to conflict because the *Aqleahs* have minimized the fervor of the society by promising reforms, which inevitably are ineffective due to corruption and mismanagement.

a.   *Ethnic Identity*

On the issue of ethnicity, respondents rate their identification with the *Aghlabeah* majority. Since only two ethnicities exist in *Doulah* (the *Aqleahs* and the *Aghlabeahs*) as shown in Table 3.1, the population map requires only one issue to measure ethnicity. Implicitly, if one identifies with the *Aghlabeah* majority, then they do not identify with the *Aqleah* minority and vice-versa.

Ethnicity	Percent of the Population	Social Status
Aqleah	34%	Ruling ethnicity
Aghlabeah	66%	Subjected ethnicity

Table 3.1   The ruling ethnicity in the country is the minority.

b.   *Equal Protection*

All citizens having commensurate legal rights under the law defines the equal protection issue. Those opposed to the issue of equal protection believe that a functioning society relies upon a protected class.

Most of the population desires equal protection, but the oligarchy and minority elite retain control over the justice system. With no incentive for change, radical reform for equal protection has not occurred within *Doulah*. As the Arab Spring begins to

gain momentum, many of the disaffected youth, minority elite, and majority elites—powerful forces affected by the turbulence of regional instability—begin to find the oligarchy weak.

Even now, before the defining moments of *Doulah's* unstable future has transpired, disaffected sentiments within the populace begin to gain momentum. Recent court rulings have not helped the government, and stand as a stark demonstration of corruption. The outrageous rulings have created martyrs out of incarcerated majority elites. Other majority elites, aided by minority elite contacts, have fled into exile where their messages remain potent. The flight of the exiles has provided the blogosphere with ample content. Though Internet infrastructure is primitive and strict censorship of the media have historically aided the government, underground movements are slowly beginning to form. The anonymous social media and hacker movements are bringing uncensored Internet to the masses through a digital underground, challenging the government's monopoly of information. These situations have effectively sown the seeds of a fractured society.

c.   *Political Representation*

Political representation denotes the degree to which *Doulahs* believe that every citizen should have equal access to the government. Public discourse identifies political representation as a right to access such as voting, eligibility to serve in government, and the ability to participate in the political process. Those opposed to Political Representation believe that the functions of government are the prerogative of the elite and the qualified.

Political Representation has led to fissures within the society. The *Aqleah* minority was loyal to French colonial rule and therefore received the benefits of Western education, upward social mobility, and positions of authority within the bilateral governing body. As the global French colonial power collapsed, the society of *Doulah* moved towards independence. The French supported a peaceful transition of authority to the *Aqleahs* who had served alongside their colonial rulers, motivated by the French desire to maintain critical access to *Doulah's* oil supplies. Soon after independence, the

government nationalized the oil industry to pay for infrastructure, government programs, and military expenditures previously managed by colonial rule. Since its inception, the *Aqleahs* have controlled the established oligarchy. Yet, access to government has transcended ethnic divides, and led to a fissure of the haves and the have-nots. After two decades of rule, tension has risen within the disaffected section of society. Those without access seek representation and demand positions within the government.

d.   Free Market

Constituents rate their support for a free market based on their belief that the government ought to relinquish control of the economy to the forces of the global marketplace. Those favoring a free market seek private ownership of land and the means of production, access to markets, and market-based pricing. Those opposed to a free market favor government control and centralized planning in all aspects of the economy.

Economically, the ruling elite manage the oil industry within the country, giving the government exclusive access to the overwhelming profits generated by the country's primary export. While the country has a rising educated class of professionals, it has not diversified its economy or infrastructure. These inadequacies led to a deficiency in occupational options. Consequently, an excess of educated youth are seeking employment. The social and economic structure has caused a deficit in professional and technical jobs for the frustrated youth bulge. Finally, the lack of infrastructure development has forced *Doulah* to export crude oil and rely upon refined petroleum imports from other countries. These issues have caused frustration within the majority of the society who favor free market reforms.

e.   Constitutional Freedom

Constitutional freedom refers to a citizen's right to free speech, religion, and assembly. It also restricts censorship. Those opposed to constitutional freedom fear the impact that those freedoms would have on society.

Constitutional freedoms have gained traction within *Doulah* as the world globalizes and the constituents increasingly have access to information sources outside

the state controlled media. Overwhelmingly, the youth and the liberal elite wish for constitutional protection for rights, such as the freedom of speech, religion, and association. Opposing reform, the conservatives and government sympathizers within the country fear the impacts that such protections would have upon the society. Yet, the government realizes that the momentum belongs to the youth and the elites, so it has made promises of progressive amendments to the constitution. The rhetoric has quelled both sides of the debate without driving meaningful change.

3.   The Coalitions within the Population

a.   *Hardcore Regime Supporters*

Five percent of the population represents the hardcore regime supporters. This group identifies entirely with the government's conservative ideology because their livelihoods depend upon the success of the current oligarchy. The *Aqleahs* overwhelmingly make up this bloc.[97]

b.   *Hardcore Opposition*

Three percent of the population makes up the hardcore opposition. This group represents the ideological opposite of the hardcore support. Ethnically *Aghlabeah*, they hold extremely liberal positions.

c.   *Minority Sympathizers*

Twelve percent of the population makes up the minority sympathizers. Ethnically *Aqleahs*, they support the government's ideology, but hold more temperate views because they do not have direct ties and access to the oligarchy.

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[97] McCormick, "Things Come Together,"

d.   Majority Sympathizers

Eleven percent of the population represents the majority sympathizers. The majority sympathizers are comprised of *Aghlabeahs*, and are happy with the status quo. While they hold more moderate positions than the government, they still tend to relate with its ideology.

e.   Minority Liberal Elite

Three percent of the population represents the *minority liberal elite*. Ethnically *Aqleahs*, they have positions of power and influence within the society, but they do not have direct connections to the government. The minority liberal elite generally have higher education—to include degrees from Western colleges and universities—and they ideologically differ from the government on all issues except ethnicity.

f.   Majority Liberal Elite

Seven percent of the population makes up the *majority liberal elite*. They hold positions similar to their minority counterparts, with the exception that they tend to hold more radically liberal ideologies—a product of their upbringing in the disenfranchised majority status.

g.   Minority Frustrated Youth

Thirteen percent of the population represents the *minority frustrated youth*. Although ethnically *Aqleahs*, they tend to diverge from the ideology of the older generation of power. Not only does the minority frustrated youth care less about ethnicity, they also seek a new path for the country. A product of a broken national economy in a globalizing world, they differ in their strong desire for constitutional freedoms and free market economics. Despite their reformist ideology on all issues, the minority frustrated youth have greater diversity of opinions than a typical voting bloc does.

h.   *Majority Frustrated Youth*

Twenty-four percent of the population composes the *majority frustrated youth*. Like their minority counterparts, the majority frustrated youth are a loosely aligned constituency. They also hold liberal positions on all issues and tend to be more radical than the minority frustrated youth. Although *Aghlabeahs*, ethnicity does not drive their ideological positions.

i.   *Opposition Minority*

One percent of the population represents the *opposition minority*. Ethnically *Alqeahs,* they have moderately liberal ideologies. The opposition minority does not have the ideological purity of the liberal elite or consensus, but they take opposing positions to the government.

j.   *Opposition Majority*

Twenty-one percent of the population makes up the *opposition majority*. They care significantly about their *Aghlabeah* ethnicity, but hold moderately liberal views on all other issues. Like their minority counterparts, their positions are not uniform in alignment.

4.   Fervor

A country in equilibrium has low fervor for issues with revolutionary potential.[98] *Doulah* is initially in equilibrium, which is a product of both natural and artificial control over the population.[99] Despite the diversity of ideologies in *Doulah's* population, the people have little fervor across-the-board. Several decades under the current government have established social mores that oblige the populace to accept conditions. Regardless, the country is not thriving.

Doulah's lack of prosperity is due to the constructs of society that limit upward mobility and foster discrimination. Hardworking families can obtain sustenance, but there

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[98] Johnson, *Revolutionary Change*.

[99] McCormick, "Things Come Together."

is little hope they or the next generation will progress beyond their current station. The government propagates a pro-regime message by controlling the media and censoring communications, even though their heavy handed approach to Internet censorship has created the proliferation of underground Internet access and online forums for revolution. In spite of the controversial and discriminatory techniques of *Shorta Khasa*, the society has moderate fervor for the equal protection issue; a condition that is only obtainable in *Doulah* through harsh artificial control measures. Finally, the stagnant economy and the impact of the global economic crisis have caused frustration on economic issues that lead to an increase in fervor for the free market issue.

5. **The Population Map**

a. *Polling and Histograms*

Polling the society provides data that the population map uses to depict the human terrain. A polling company compiled its results on the ideological positions and the fervor for each of the five issues previously described in *Doulah*. For simplicity and clarity, the *Doulah* example first presents one issue in detail—Political Representation. The poll drew a 20,000 person sample of the 20 million citizens from *Doulah*, and the data was added to the model. Using the model to make an analysis, one makes inferences about the distributions and positions of the population at large.

Understanding how to read the polling data, and the graphs it generates, is critical for reading the political map. Explaining the components of the graphs is the first aspect of describing how to interpret the polling data. The following paragraphs in this section explain how to interpret the differing values of fervor between graphs.

The graphs in Figure 3.1 are standard histograms that collectively depict three aspects of a single preference. Figure 3.1-A depicts, 'Ideology – Political Representation,' the basic data allocated to explain the ideology of the society for a single issue. Next, Figure 3.1-B depicts, 'Preference – Political Representation with Low Fervor,' the same data captured in 3.1-A. The exception between the graphs is the preference. Rather than the ideology, which has no fervor depicted, the preference accounts for a low degree of fervor for the issue. Finally, in Figure 3.1-C, the 'Preference

– Political Representation with High Fervor,' depicts the same ideological stance on the issue, except that the society manifests high fervor for the issue. Notice the obvious change in scale between the three figures.
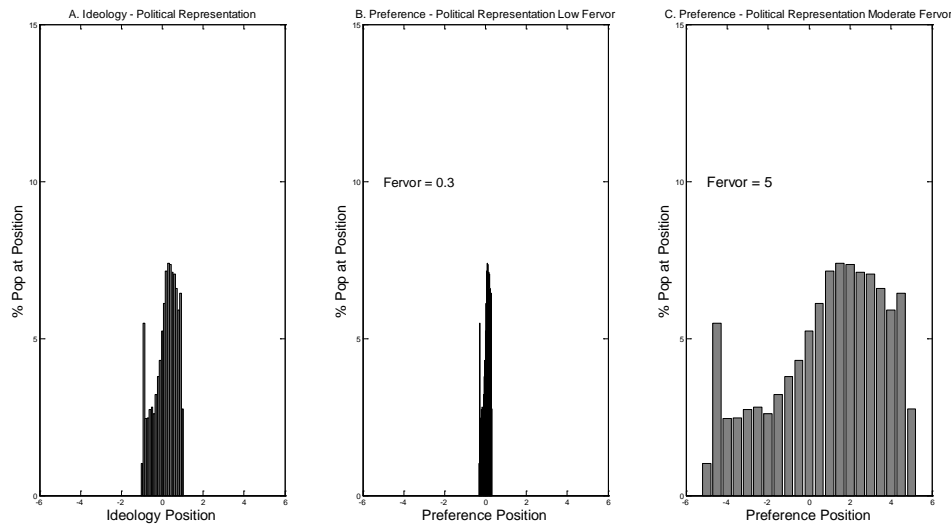
Figure 3.1   Histograms for Ideology and both low and moderate fevor Preference

The histogram bins along the x-axis, which appear as vertical bars in the graph, represent the compiled polling data. In Figure 3.1-A the scale of the 'Ideology Position' is negative one to one, which holds true for all ideology histograms in this thesis. In this example, the negative one end of the spectrum depicts those who believe that Political Representation is the privilege of a select few; conversely, one represents those who believe Political Representation is a right equal and common to all in the society.[100]   Like the ideology position histogram, the compiled bins in Figure 3.1-B represent the same compiled polling data. However, unlike the graph depicting ideology, the preference graphs now include the fervor component of the model. The degree to

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[100] It is the polling official's responsibility to survey this issue correctly. An ideological position of 'one' would indicate a radical position compared to a typical Western democracy. For instance, a position of 'one' corresponds to a person who believes in a completely representative form of government, where every act of the government follows from referendum and no distinction exists between a government official and a constituent. A negative one is anarchy.

which the scale of the ideology positions change demonstrates the fervor for the issue. The *y*-axis provides the percentage of the population that exists in each bin, known as a *density*.

The value of *y* does not change as the fervor increases. Rather, as the fervor increases, the scale of the *x*-axis changes, making the graph look either stretched or compressed. Preference is a product of both the ideology and the fervor. Notice the difference between Figures 3.1-A, 3.1-B, and 3.1-C. Between them, the shape of the histograms remains the same, but since the scale has changed, 3.1-B appears compressed and 3.1–C appears stretched. Furthermore, the scaling of fervor is always a positive value, but when the fervor for an issue drops below one, the preference position appears compressed when compared to an ideological position for the same issue. Notice the opposite effect when scaling the same ideological preference with the higher fervor of five depicted in Figure 3.1-C. The increased fervor exhibits an expanded scale, which depicts the preference histogram on a larger scale than the original ideological graph.

In all of the graphs, the area within the bins equals one, representing 100 percent of the population. As such, one can estimate the proportion of the population around any ideological or preference position, by taking the desired distance along the horizontal axis multiplied by the average value of the curve along the vertical axis.

For example, to estimate the proportion of the population including bins from 0.25 to 0.5 on the issue of Political Representation, one multiplies the value of the included bins. In other words, taking approximately 0.2 (the average value of the curve between 0.25 and 0.75) times 0.5 (the distance along the horizontal axis) yields 0.10 or that 10 percent of the population is within a distance of 0.25 from the position of 0.5 regarding their preference for free market economics.

Figure 3.2 depicts the full ideology and preference positions for all of the issues polled in *Doulah*. The polling institute found the fervor for the issues as follows— ethnicity 0.68, equal protection 2.16, Political Representation 0.79, free market

economics 2.61, and constitutional freedoms 0.57. *T*he preference graphs below the ideology graphs preserve the shape of the curves and scale them according to the population's fervor.
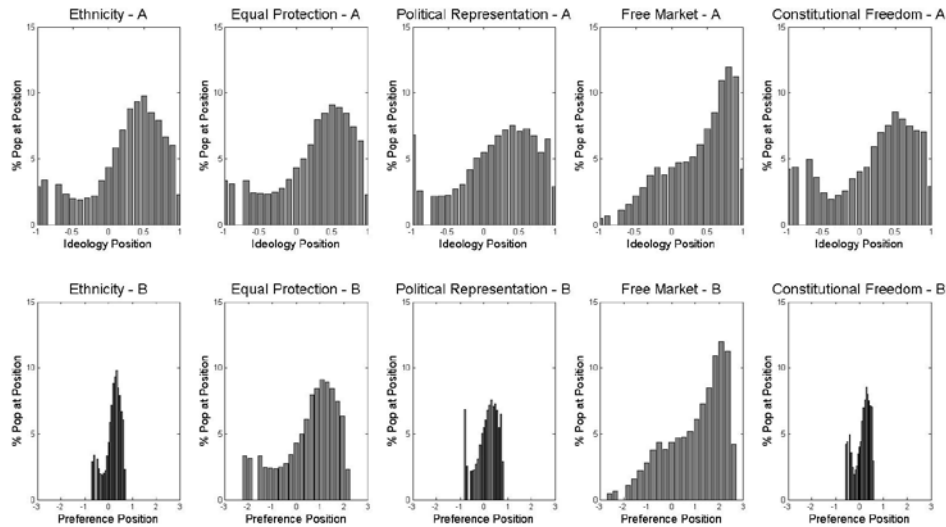
Figure 3.2   Histograms for all issues facing *Doulah*

These preference curves weave together in the five-dimensional model (i.e., the dimensions represent the issues in the country) to create a hyper surface, which this work defines as a preference surface.[101] The preference surface provides the key to determining the proportion of the population that a coalition with a given ideology can recruit through natural control. Similarly, it gives insight into the cost of recruiting a population through artificial control.[102] In order to determine these values, the polling company determined the net utility curve of the constituents of *Doulah*.

b.   *Utility Curve*

Figure 3.3 displays the utility curve for "Alice," a citizen of *Doulah* who is being measured against the governing coalition. The utility curve represents the cost-

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[101] See the math appendix for an explanation of a hyper space.

[102] We provide a brief review of the process as it applies specifically to *Doulah*, but see Chapter 2 for a robust explanation.

benefit analysis that she engages in to determine whether or not to support the coalition. Alice seeks to maximize her benefits while maintaining her ideological stance on an issue.[103] The **x**-axis at zero depicts the ideological position of the government coalition across the spectrum in *Doulah*. The utility curve, illustrated by the diagonal line, explains Alice's perception of her ideological position in relation to the government. Her position in relation to the government coalition at any given point along the curve can be measured along the **x**-axis as distance. For simplicity Alice's utility is labeled at points (a), (b), and (c) in Figure 3.3. These three points depict valuable positions that explain the maximum utility of supporting the government (a), how natural control impacts the utility curve, (b), and the intersection of the cost of conflict with the range of normal politics (c).
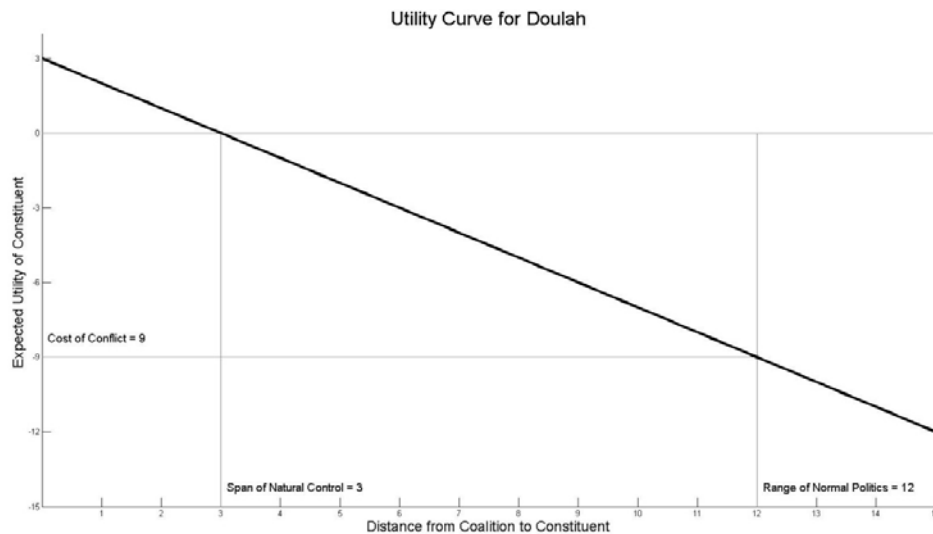
Figure 3.3   Alice's utility curve

Notice the expected utility of Alice at position zero on the x-axis. At zero she is ideologically aligned with the coalition. At point (a), Alice perceives a net utility (benefit minus cost) of three, in this case her maximum utility. As Alice moves along the x-axis to point (b) her utility value decreases in direct relation to her distance from the coalition.

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[103] Owen and Grofman, "Two-Stage Electoral Competition in Two-Party Contests: Persistent Divergence of Party Positions.,"

Increasing the distance between Alice and the government along the preference surface decreases the benefits she can expect from supporting the coalition. In other words, the further her preferences are from the government's preferences, the less benefit she will receive from supporting the government's coalition. At (b), Alice is a distance of three away from the government and expects a net utility of zero. A net utility of zero demarcates the government's span of natural control. At any point between Alice's utility being three and zero she benefits from affiliating with the government and therefore falls within the coalition's span of natural control. At a distance greater than three on the *x*-axis, Alice expects a negative utility from supporting the coalition. Any value of three or greater encourages Alice to seek alternative coalitions to support due to the imposition of costs that outweigh perceived benefits. Alice's utility curve also depicts the intersection of the cost of conflict with the range of normal politics (c).

In *Doulah* the autocratic regime uses strict control measures applied by *Al Shorta Khasa* to impose hefty costs to those who contest its authority. In economic terms, it imposes an expected cost of nine, or a negative utility, to those who would resort to rebellion. As Alice moves to the right along the preference surface her net utility continues to decrease. At point (c) Alice reaches the intersection of the cost of conflict and the range of normal politics. The cost of conflict is a net utility of negative nine, and is located on the *y*-axis. The range of normal politics is a distance of twelve from the government, and is located on the *x*-axis. When Alice is at any distance between 3 and 12 she participates in the normal political process. At a distance of twelve, the negative utility in supporting the government's coalition equals the cost of conflict. This demarks the point at which a rational constituent considers violence and rebellion against the distant coalition. Any constituent further than twelve from the coalition finds the costs of participating in the normal political process worse than fighting.

The utility curve in Figure 3.3 denotes one additional facet of *Doulah's* populace—the cost of recruiting artificial control. Assume a constituent holds ideological positions that place her at a distance of six from the government's ideological platform on

the population map. Her net utility from supporting the government is negative three. If the government is efficient, it can offer a side payment of at least three dollars to raise her perceived utility into the positive range.

Since Alice represent her constituency in this hypothetical situation, it follows that the government does best to attempt to elicit artificial control (beyond the span of natural control) among those constituents who lay closest to the government coalition on the population map. However, the value of artificial control is up to the government's discretion based upon the amount of money it can disburse and the perceived strategic benefit it gains. The maximum threshold for artificial control is reached when the government reaches a point of diminishing returns from implementing artificial control. As an arbitrary value, artificial control's maximum threshold is largely determined by the resources available to the coalition and their perceived requirement to expand the coalition.

c.   *Doulah's Incipient Insurgency Population Map*

With the polling results and the utility curve for *Doulah* thus defined, the population map produces the model depicted in Figure 3.4. As described in Chapter II, the population map takes the preferences of the polity for the various issues in the society and reduces them into the two most significant spectrums of division (such as liberal to conservative on the economic and social scales in the U.S. system). The map uses linear algebra to accomplish this reduction from five dimensions (issues) to two dimensions (issues).

Note that Figure 3.5 does not explicitly label the horizontal and vertical axes, but it does portray the projection of the issues onto the population map. The mapping system is strictly an objective tool and labeling the axes (such as liberal to conservative) is a subjective assessment. The map does provide intuition for how to label the axes by portraying the effects of each issue.

Figure 3.4 is an expanded view of the legend icon for the ethnicity issue. The structure of the icons has two primary components. The first component (A) is the vector of the issue, signified by a line that extends the diameter of the icon. The top issue,

ethnicity, generally impacts the map in a southwest to northeast direction. Implicitly, if one increases the fervor for ethnicity, then the map will stretch in this direction. Conversely, if one decreases the fervor for ethnicity, then the map will compress in this direction. The second component (B) is the strength of each issue acting on the population map. The strength of the issue is denoted by the number under the image (C) and the length of the thick black line.
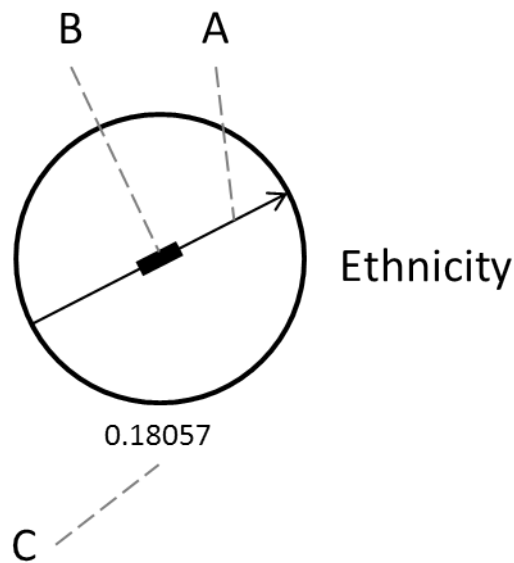
Figure 3.4   Ethnicity Issue

Referring back to Figure 3.5, notice that equal protection has a relative strength of about 0.96. Meanwhile, ethnicity has a relative strength of only about 0.18. This implies that equal protection has a much greater impact on the population map than ethnicity does. Expanding on the polling results from the histogram in Figure 3.1 the thesis turns its attention to two issues affecting the country, equal protection and free markets as shown in Figure 3.5. This is because the values are so great as compared to the other issues (0.9638 and 0.98395, respectively).
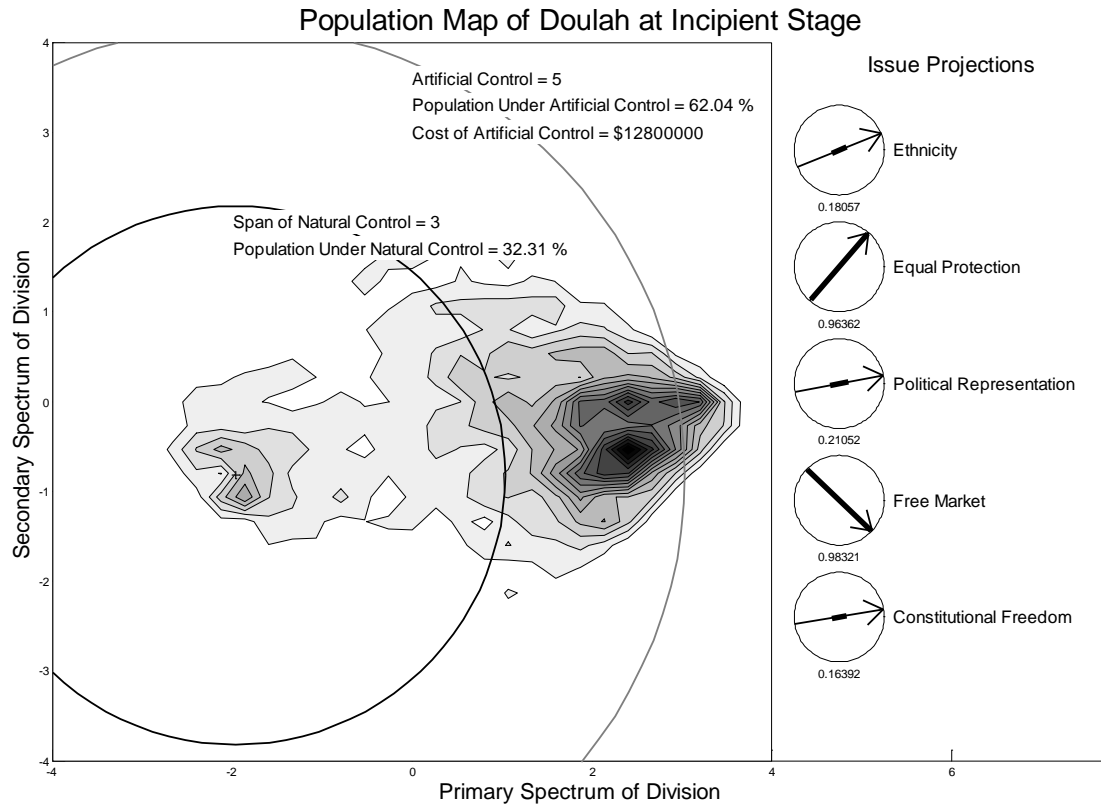
Figure 3.5   Population map of *Doulah* at incipient stage

In Figure 3.5 two coalitions are evident. The graph depicts the
government's coalition on the left, and the mainstream position of society on the right.
The government's preference for issues, denoted by the black '+', is surrounded by two
concentric circles. The smaller concentric circle displays the span of natural control in
Doulah. The government coalition maintains control of 32.3 percent of the population
through natural control. Notice, the majority of the constituency lies outside the
government's natural span of control. The autocratic regime compensates for the lack of
control by recruiting assisted preference and establishing artificial control. The larger
concentric circle represents the government's span of artificial control reaching out to a
distance of five. Because *Doulah* has relatively low fervor for most issues, this captures
an additional 62.0 percent of the population under the control of the autocratic regime.
Based on the utility curve of Figure 3.3, this will cost the regime a minimum of $12.8

64

million. The government cannot afford to skip these payments, as it depends on substantial control in order to maintain its rule in a single-party system. Between natural and artificial control, the government recruits 94.3 percent (i.e., 32.3 percent natural control plus 62.0 percent artificial control) of the population achieving relative equilibrium.

The map suggests a large coalition might oppose the ruling body if not for the artificial control that the regime enacts. Namely, the large proportion of the population located to the right of the map has the potential to form a substantial opposition coalition. In an autocratic system, this would almost certainly lead to conflict. Based on the map, increasing fervor for issues with projections in the east-west direction would lead to rapid governmental power deflation in *Doulah*, since it would push the majority of the population outside the range of the regime's artificial control. Note that increasing fervor on any issue would stretch the map and hence decrease the control of the regime, but the east-west issues would have the most significant impact. This map sets the stage for the first phase of the rising insurgency in *Doulah*. The government has an ideologically divided constituency, but it keeps fervor low enough to permit the recruitment of artificial control at an affordable price to the oil rich regime. Yet, because fervor is dynamic, artificial control can vanish in an instant.

C.   A CIVIL WAR IN *DOULAH*

1.   Scene 1—Incipient Rebellion

On December 18, 2010 in the town of Sidi Bouzid, Tunisia, Mohammed Bouazizi conducted a heinous act of self-immolation, which immediately became a harbinger of things to come throughout the Middle East. *Doulah*, like Tunisia, has a precarious grip on its populace. The status quo, which many tolerated for years, quickly becomes a point of contention as thoughts of rebellion spread like a contagion. Public demonstrations across North Africa and the Middle East encourage the citizens of *Doulah* that change is afoot and the opportunity to act must be exploited. In the wake of the regional upheaval, the

common sentiments of relative deprivation and oppression emerge to inspire public outcry for change and the courage to take action.[104]   Long tempered frustration boils to the surface of *Doulah* society.

The spirit of the Arab Spring has an immediate impact upon the frustrated youth's fervency regarding constitutional freedoms   As protestors take to the streets, the government responds by employing both the military and *Al Shorta Khasa* in an attempt to quell the brewing rebellion. Tempers flare, as the indignant protestors grow increasingly fervent about their pre-existing positions on freedoms. In response, those who believe that a closed and controlled society better serves the interests of the public good become increasingly entrenched upon their position. In the population map, *Doulah's* ideology for constitutional freedoms remains the same, yet the increased fervor has increased the distance between the two camps on the preference distribution. With an initial value of 0.57, the fervor starts very low in *Doulah*. The Arab Spring has caused it to rise to 1.58, which approximately triples the perceived distance between the populace as it relates to the issue of constitutional freedoms. Figure 3.6 displays the results of the static ideology and how it scales into preference in the low fervor society before the Arab Spring versus the increased fervor society during the Arab Spring.
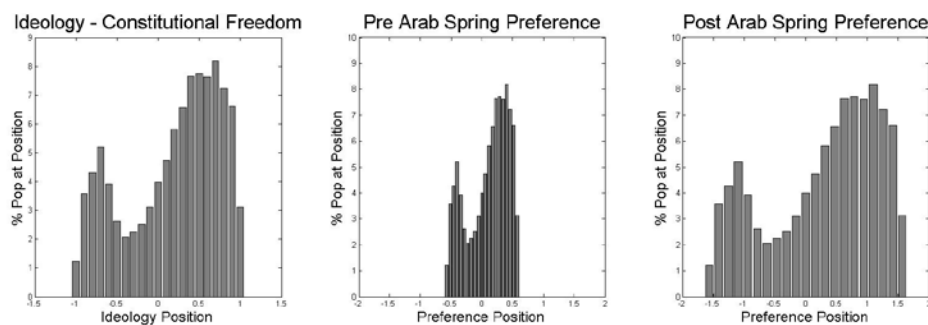
Figure 3.6   Histograms of static ideology and pre and post preferences during Arab Spring

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[104] Ted Robert Gurr, *Why Men Rebel*: *Fortieth Anniversary Paperback Edition* (Boulder: Paradigm Publishers, 2011).

The movement that commenced with the frustrated youth starts to embolden the regime's silent opposition and the liberal elite. They have always held ideologies that differ from the government's positions, but low fervor kept them from acting on their beliefs. Now these groups engage in public discourse and deplore the state of the economy. They demand immediate economic reforms and access to the political process previously denied. Prior to the events of the Arab Spring the populace accepted the state of these affairs as norms. The fervor for these issues increases as a surge in protests gain momentum in *Marbah Square*. What the movement lacks in organization it makes up for in numbers. Associated Press reports indicate that tens of thousands have joined the demonstrations and even the government controlled *Al Khibra* news organization acknowledges the discontentment.

On the map, Figure 3.7, the passion of the protestors correlates directly to an increase in fervor for the issues of free markets and political representation. The issue of Free Markets increases from 2.62 to 3.11 in fervor. Similarly, the issue of political representation increases from 0.79 to 1.79. Note that these increases in fervor do not appear directly on the map. Instead, the change the political landscape and hence alter the contour of the map. An increase in fervor influences the perceived distance between constituents and the government, causing the map to stretch. This stretching has enormous consequences for a government that relies upon artificial control in order to maintain its power.
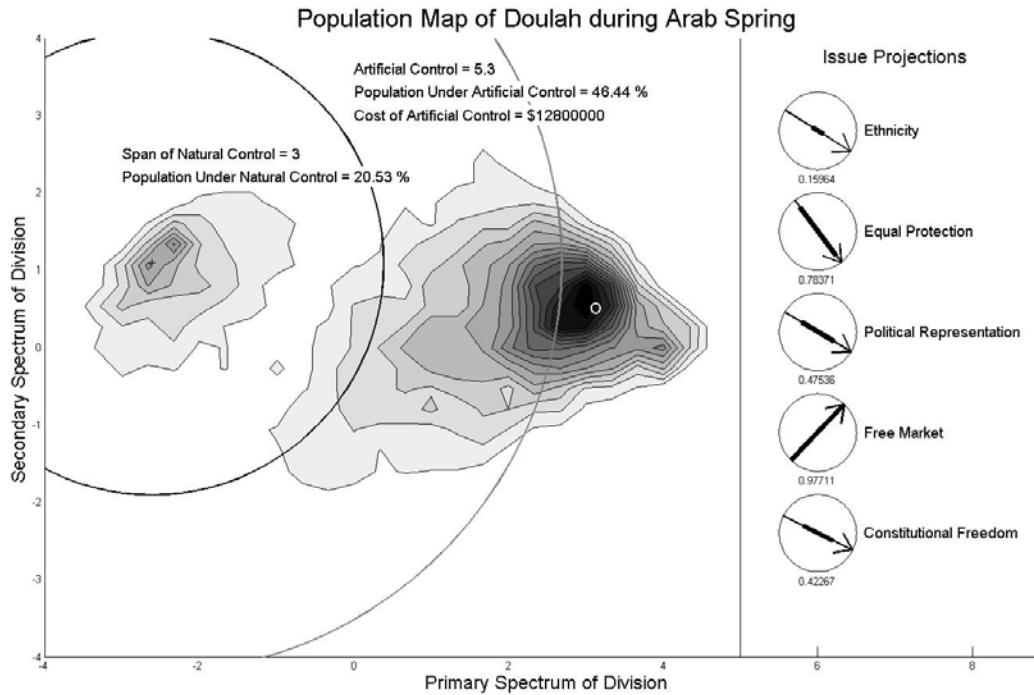
Figure 3.7   Polulation Map of *Doulah* during Arab Spring

Figure 3.7 displays the impacts of the increased fervor for the issues fomented by the Arab Spring. A stark contrast exists between this map and the map depicted in Figure 3.5, which displayed the map prior to the protests. Prior to the Arab Spring, the government controlled 32.3 percent of the population through natural control, but the rising fervor pushes constituents away from the government leaving only 20.5 percent who perceive a net benefit from continuing to support the coalition. Previously, the government spent $12.8 million to recruit the artificial support of 62 percent of the population. Under the new map, increased fervor diminishes the proportion of the population swayed by the government's budget, and now it receives just 46.4 percent of the population through artificial control. Prior to the Arab Spring, the government had a total of 94.3 percent of the population under its control. Now, it has only 67 percent. While still enough to maintain a majority, this sudden drop in control naturally worries the regime.

The map displays another trend that will plague the government—an emerging coalition. The densest part of the population appears as the darkest spot on the map to the right of center marked with an '*O*.' The *O* represents the greatest density of the population with similar ideologies. Notice how the epicenter has drifted outside of the government's artificial span of control. As the plurality begins to perceive a net loss from supporting the government, they begin to conspire. Prior to the Arab Spring, dissenters existed within the constituency of *Doulah*. Yet, the map in Figure 3.5 demonstrates that at that time there was insufficient cause to rally a consensus. Furthermore, the lack of an effective motivator prevented an opposition coalition from forming. Now, as the map begins to change, a developing coalition emerges outside the realm of government control. Nearly one-third of the population outside the regime's control mechanism organizes.

The government responds in a fashion typical of an autocratic regime accustomed to rule in a one-party system; they declare martial law, impose a curfew, send out *Al Shorta Khasa* to harass and jail protestors, and increase censorship. This overreaction on the part of the government exacerbates the rising tensions. Fervor continues to increase as the government attempts to impose greater control over its populace. The indignant population now increases its fervor for Equal Protection to 6.18, indicating a significant jump. Similarly, fervor for Political Representation, Free Markets, and Constitutional Freedoms increases to 2.80, 3.31, and 5.08, respectively. As before, the fervor does not appear overtly on the map. The changes in fervor alter the preferences of the population, which in turn changes the contour of the map and accounts for the visible differences between Figure 3.7 and Figure 3.8.

The updated map in Figure3.8 demonstrates the effects of the increasing fervor. At this point, the government maintains the same $12.8 million budget to fund its artificial control programs, but it receives and abysmal 3.8 percent support. The increased fervor has led to a majority of the population perceiving a net cost from supporting the autocracy. More importantly, a significant portion of the population feels at a distance greater than 12 from the government, to include the budding opposition coalition denoted by the *O* on the map. Since the range of normal politics in *Doulah* is 12, all of these

constituents at a distance greater than 12 feel that the cost of continuing to support the government exceeds the cost of conflict. In other words, they would rather fight than participate in the political process.
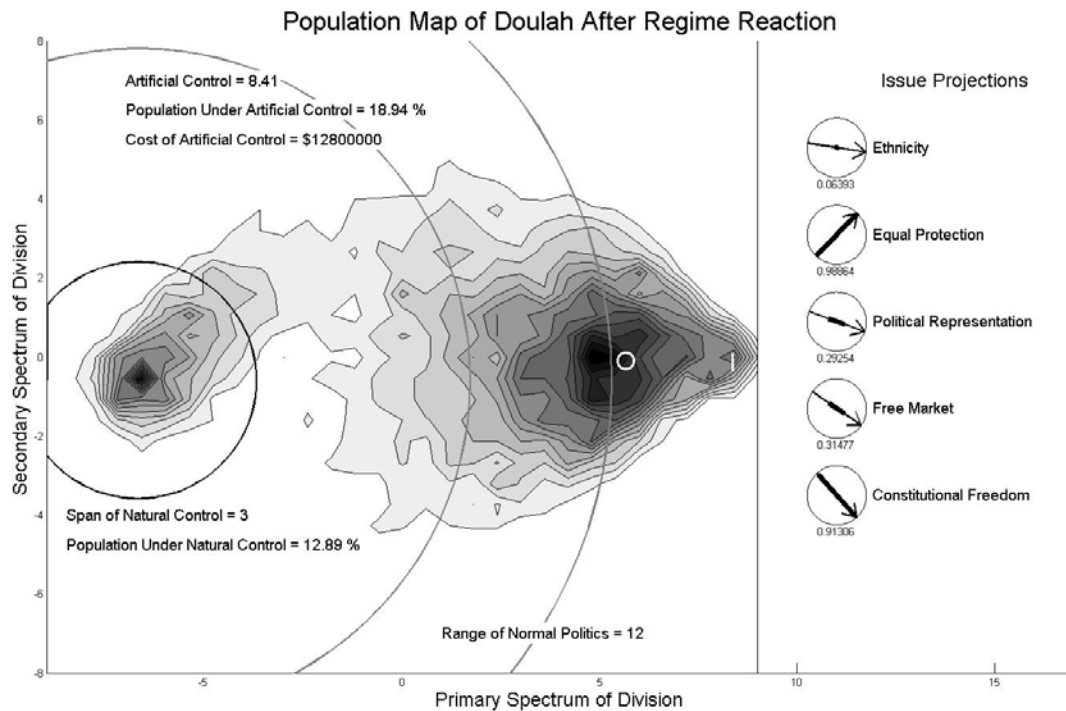
Figure 3.8   Population map of *Doulah* after regime change

Figure 3.8 also displays an extreme insurgency forming at the outskirts of the population map, denoted by the '*I*'. Initially, these radicals blended in with the rest of the population. But, as the fervor stretches the map, they have appeared as a distinct element within society. They are ready to move beyond the incipient stage; they can no longer hide their intentions in a society ripe for civil war.

After two months of relatively peaceful—though passionate—protests, things take a distinct turn for the worse with the spark of violence. An extremist element of the opposition, located near *I* on the population map, decides to retaliate due to the transgressions of the regime. Government infrastructure is tightly guarded making softer targets more attractive. *Club Nada*, a high-end nightclub in the capital's downtown

district, is targeted by the extremists due to the frequent patronage of regime members and their affiliates. In the peak hours of the evening rush, a large parcel bomb explodes in the club killing dozens and wounding over a hundred. Civil war has begun in *Doulah*.

2.   Scene 2—Mobilization

The night club bombing confirms the government's worst fears—the general opposition has evolved into a full blown insurgency. The insurgent forces organized and resourced the current conflict during their incipient phase. Now, they emerge from the shadows to openly compete with the government for control of the populace.

Figure 3.9 displays the relative strengths of the regime and the insurgents at the start of the conflict. Initially, the regime recruits 12.9 percent of the population through natural support while the insurgency recruits 15.0 percent. The government can account for this difference because it has far greater resources. With its budget of $12.8 million for artificial control, it garners an additional 18.4 percent of the population. The insurgent, strapped for resources, spends a hundred times less than the government. Still, its proximity to the population allows it to recruit 4 percent support for this modest investment. Therefore, at the start of the violence the government has a total coalition of about 31.8 percent and the insurgency has a total coalition of approximately 19.0 percent.

Population Map of Doulah at Start of Civil War

Issue Projections

Ethnicity — 0.06393

Equal Protection — 0.98864

Political Representation — 0.29254

Free Market — 0.31477

Constitutional Freedom — 0.91306

Government Natural Control = 12.89 %
Range of Artificial Control = 8.41
Government Artificial Control = 18.94 %
Cost of Artificial Control = $12800000

Insurgent Natural Control = 14.95 %
Range of Artificial Control = 3.34
Insurgent Artificial Control = 4.02 %
Cost of Artificial Control = $129000

Secondary Spectrum of Division

Primary Spectrum of Division

Figure 3.9   Population map of *Doulah* at start of their civil war

Of course, in the midst of violent conflict, the population map does not remain static. While ideologies do not change among the populace, their passions for various issues do change. The *Club Nada* bombing may have sent a powerful message to the government, but it had an unintended side effect; the patrons of the club are mostly the ethnic *Aqleahs*.[105] Since civilians and off-duty officials were present at the time of the bombing, the *Aqleahs* feel that the *Aghlabeahs* have singled them out for their ethnicity. In truth, the insurgents do not want an ethnic fight since they rely on *Aqleah* dissenters and frustrated youth to fill their ranks and sympathetic support. But, in the midst of violence, the fervor of the people can lead to unintended consequences.

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[105] McCormick, "Seminar in Guerrilla Warfare." McCormick contends in his seminar that in order for an insurgency to grow they must take action that communicates to the population they are a viable threat to the government. Garnering support for their insurgency through violence is one critical component of insurgent strategies. McCormick explains the concept academically in his work, "Thing Come Together" (2007). Symbolic violence, as McCormick explains, an effective method for communicating the strength of an insurgency. A weak insurgency is not able to conduct complex attacks with high explosives as frequently or effectively as a strong insurgency.

Figure 3.10 displays the evolution of the map. The perceived ethnic targeting in *Doulah* has increased fervor for ethnicity from 0.68 to 5.19. An almost negligible issue of ethnicity has become a cornerstone of the violence. As fervor rises for ethnicity, it falls for markets. The society maintains a high total level of fervor, but the sudden increase in ethnic divisions places a temporary hold on economic considerations. In this new map, the insurgents have lost ground to the ethnically aligned regime. The increase in ethnic tensions reduces both coalitions, but the ethnically diverse insurgency suffers more than the homogeneous regime.
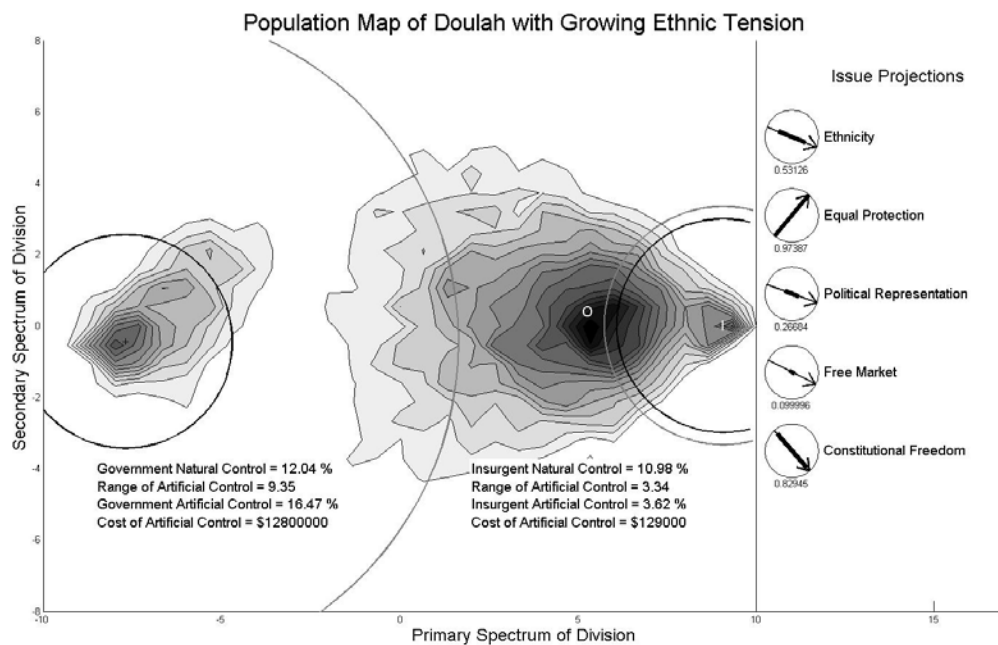
Figure 3.10   Population map of *Doulah* with growing ethnic tension

All is not lost for the insurgency. As the violence has seized the nation of *Doulah*, the insurgency has tapped into additional financial assets—one of the three critical components of a growing insurgency.[106] Their overt presence in the society has allowed

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[106] McCormick, "Seminar in Guerrilla Warfare." According to McCormick, insurgencies are either growing or they are shrinking. In order for an insurgency to grow it must have people, guns, and money. As the insurgency gains in those three aspects, they become mutually supporting components of the whole, which furthers the insurgent cause.

them to expand their resources by accessing the populace. An insurgent-based shadow government forms in insurgent controlled territories that tax the population while the leadership solicits support from sympathetic governments throughout the world.[107] The insurgents' modest budget for recruiting artificial control increased five-fold to $640,000. Its proximity to the population allows them to recruit an additional 8.2 percent support from the population, a greater return on investment than the government can achieve with its growing distance from the population. The insurgency—having learned from the errors of the government's decline—also makes a crucial strategic decision. The insurgents who initially sparked the violence realize that by moderating their preference platform to the position of the general opposition located at the *O* on the map, they can achieve far greater support. Note that the government could have made these conservative changes prior to the onset of violence by moderating its positions to meet the preferences of the populace.[108] As an autocracy accustomed to an uncompromising system, it failed to make this wise strategic shift. The infant insurgency has remained far more flexible by sheer necessity. As such, it makes the wise shift in platform to enlarge its sphere of influence. Figure 3.10 displays the population map when the insurgents have increased resources. Figure 3.11 depicts the strategic move of the insurgent's platform to coincide with the greatest density within its span of control.

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[107] Leites and Wolf, "Rebellion and Authority: An Analytic Essay on Insurgent Conflicts."

[108] Johnson, *Revolutionary Change*.
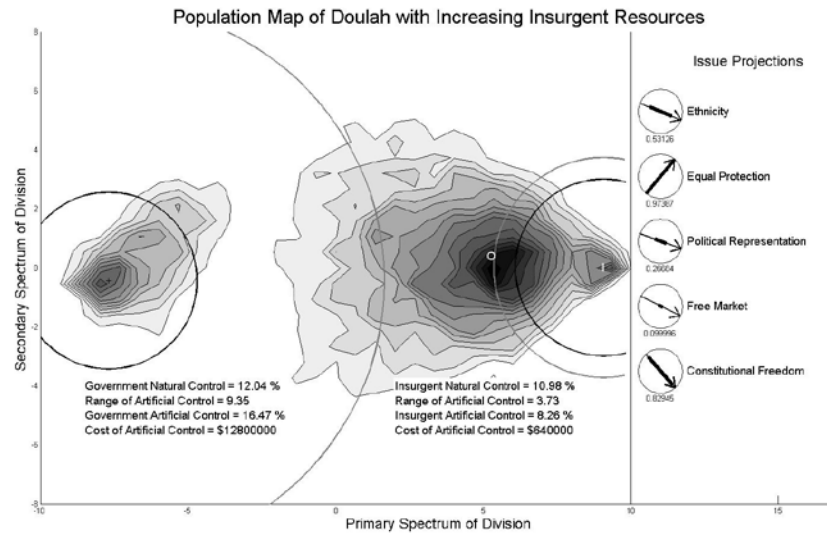
Figure 3.11   Population map of *Doulah* with increasing insurgent resources
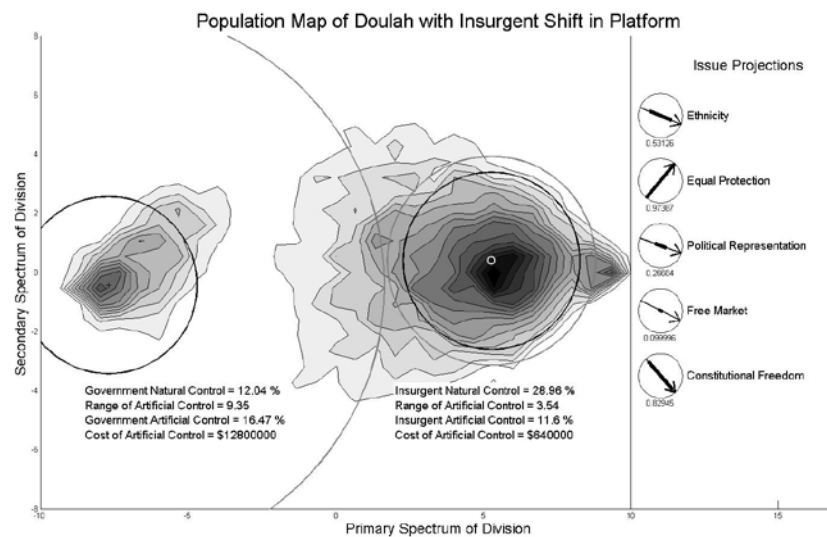
Figure 3.12   Population map of *Doulah* with insurgent shift in platform

The regime makes a strategic decision as well. Realizing the relative benefits that sectarian violence brought to its side, it decides to attempt to further exacerbate ethnic fervor by sending *Al Shorta Khasa* to bomb a series of *Aghlabeah* markets. The ploy is effective and ethnic tensions soar from 5.2 to 8.6. The actions of *Al Shorta Khasa* cause a

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slight increase of 0.2 in fervor for protection. As the rise in fervor for ethnicity and equal protection demands the full passion of the populace, fervor for constitution freedoms falls from 5.1 to 4.1.

Figure 3.13 shows the current state of affairs in *Doulah*. As violence has continued to plague the country, the rising fervor has exposed weaknesses within the opposition's coalition. The insurgency still maintains greater control than the government, but it has started to suffer from some infighting. Meanwhile, the ideologically homogenous government has remained a consistent, although isolated, coalition. Still, at this point the insurgency has gained greater support than the regime even though the regime still owns the tanks, airplanes, and heavy weapons in the society, the insurgents have started to openly contest the government in conventional engagements. *Associated Press* reports place the death toll in the tens of thousands. Those remaining outside the control of the insurgency or the regime create an internally displaced person crisis as they seek refuge from the violence. The system is rapidly devolving into chaos.
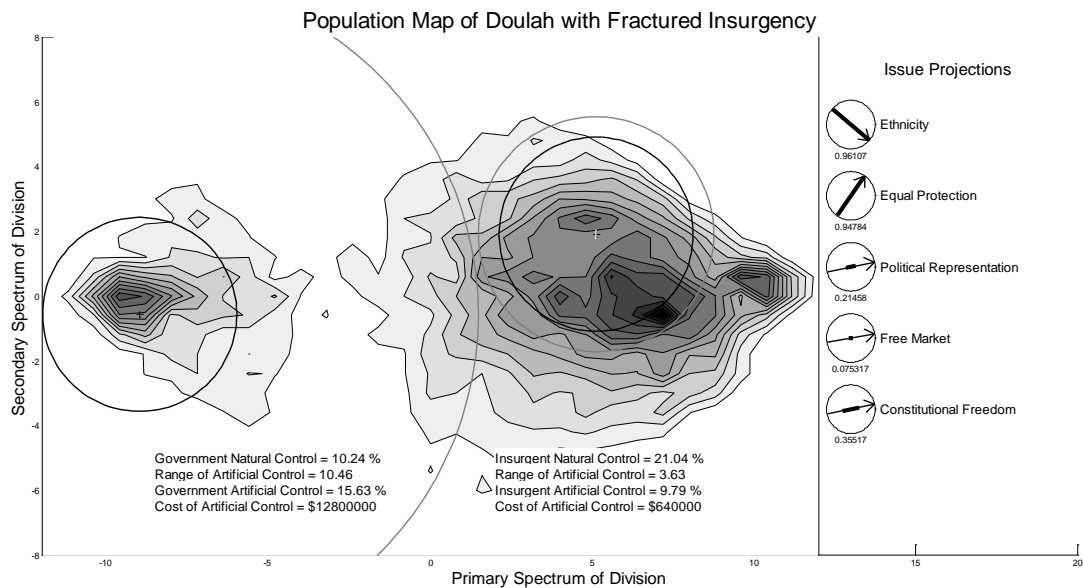
Figure 3.13   Population map of *Doulah* with fractured insurgency

As the crisis worsens the international community begins to take an interest in the disintegrating situation in the oil rich nation. Regional stability is at stake. In addition to concerns of stability, increasing reports suggest that *Al Shorta Khasa* has engaged in ethnic cleansing. The insurgency shares some serious blame regarding the brewing humanitarian crisis. Reports indicate the presence of mass graves of *Aghlabeahs* near a rural town rumored to support the insurgency. An emergency UN Security Council meeting fails to produce a resolution, but NATO prepares to respond.

3.   Scene 3: Alternate Endings

Based upon the population map, we now look at three courses of action that NATO might pursue in its attempts to bring about reform in *Doulah* and to reestablish stability in the region. Three lines of thought dominate discussions within the NATO member states. Some promote a heavy-handed intervention that utilizes NATO troops to overthrow the oppressive regime and to transition into a peacekeeping and stability force. Others advocate an approach that offers only non-lethal aid to the rebels in their attempts to defeat the government forces. Some support a blended approach where NATO provides lethal and non-lethal aid including air support, but does not place overt NATO forces on the ground. NATO, as the principle international actor in opposition to the *Doulah* regime, offers an ultimatum demanding that the government abdicate its power and allow for reform. The regime remains intransigent forcing NATO to respond.

a.   *A Heavy Intervention*

NATO forms an international expeditionary force of approximately fifty thousand troops consisting of heavy and light brigades and the logistical support to sustain them in theater. As the deadline for the *Doulah* regime to step down comes and goes, NATO initiates an air campaign to establish air superiority and rapidly launches its ground force into *Doulah*. The modernized NATO force quickly topples the government's forces, who desert en masse and blend into the population. The government follows as key members go into hiding. A moment of calm follows as NATO prepares to transition to an interim government and follow-on elections.

In the ensuing power vacuum, resentment grows among the people of *Doulah* on both sides of the conflict. While the rebels united under their opposition of the regime, their varying ideologies and the high fervor inspired by violent conflict makes it hard for them to unify under a single platform. NATO puts the issue to rest by selecting a transition government that best represents the strategic interests of the member states. However, this increases frustration among the rebels and loyalists alike, who begin to resist the foreign occupation. In misreading the tolerance for a NATO solution to a *Doulah* problem, NATO has actually created a new issue within the society.

The shaky ceasefire quickly passes as NATO forces start to come under attack from non-uniformed forces. At first, it assumes that the attacks come from former loyalists and the *Aqleah* minority. However, NATO comes to realize that the rebels and the *Aghlabeah* play a prominent role in the attacks. As it pertains to the population map, opposition to occupation has become a new issue in the society. Unfortunately for NATO, the majority of *Doulah* citizens oppose the idea of the occupation forces and the NATO instantiated transitional government. Figure 3.14 shows the results. In the map, extremely high fervor for opposition to occupation has led to a fissure along this issue.
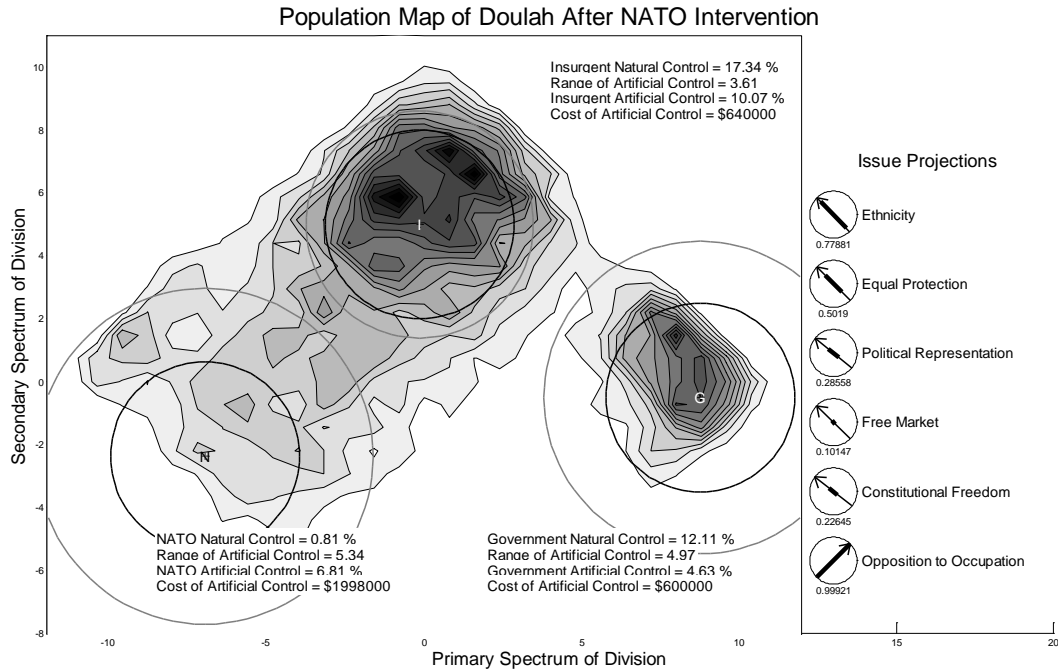
Figure 3.14   Population map of *Doulah* after NATO intervention

The NATO supported government (denoted by the 'N' on the map) does not share the ideology of the majority of the constituents. Namely, it supports the foreign intervention while the majority of the *Doulah* populace rejects it. As such, it enjoys natural control of less than one percent of the population. Even with a generous $20 million budget for recruiting assisted preference (or buying 'hearts and minds'), it still only controls a total of 7.6 percent of the populace. In fact, some members of the original insurgency (denoted by the 'I' on the map) reside at a distance greater than 12 on the map from the NATO supported government. Since the utility curve of *Doulah* demarks 12 as the range of normal politics, some insurgents feel so distant from the NATO government that they violently oppose it. As expected, the original government coalition (denoted by the 'G' on the map) continues to resist the insurgent coalition and NATO. While NATO fully intended to support the rebels, its heavy injection of forces into the country has led to a three-way conflict that has further divided the country and done little to ease tension.

In an effort to increase legitimacy and unite the rebel coalitions, the NATO forces decide to hold democratic elections. However, this well intentioned

initiative misses something clearly depicted by the population map. The span of the map is significantly greater than 12, the range of normal politics. Therefore, much of the populace believes that violence is a rational and economic option. The competitive nature of the democratic process does not fit this scenario. Based on the population map, there is no reason to expect that democratic elections will lead to a decrease in violence. In fact, the population map suggests that elections will only lead to the empowerment of agents opposed to NATO's position and the further disintegration of the opposition. NATO certainly succeeded in defeating the armed forces of the oppressive *Doulah* regime, but in the process it has created a counterinsurgency fight that will take years to resolve.

b.   *Non-Lethal Aid Only*

In the following course of action, NATO decides to respond by providing only non-lethal aid to the rebel forces. While the member states generally agree that the prevailing regime must abdicate power, weariness from a decade of persistent conflict and the geopolitical implications of an intervention has left NATO unwilling to commit beyond providing political support, advice, and non-lethal services to the insurgent coalition.
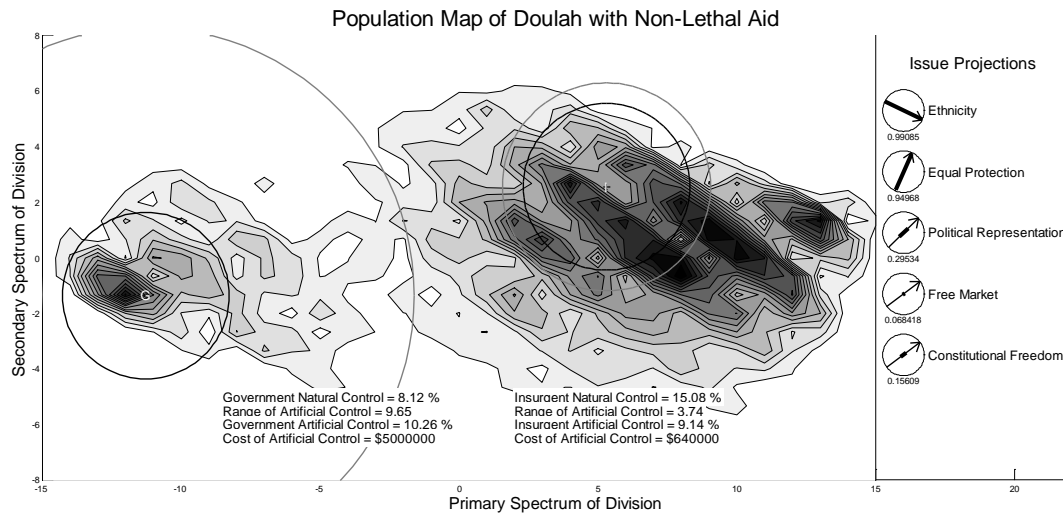
Figure 3.15   *Doulah* after an increase in tension over ethnicity.

The population map, Figure 3.15, depicts the results of this policy. The *Doulah* government still controls the military, to include tanks, artillery, and bombers. Still, the toll of the fight on the resources of the government and the economy of *Doulah* forces the regime to decrease its budget for its artificial control regime. Now, it spends only $5 million on recruiting support versus the $12 million that it could previously afford. It uses its remaining military in a full-fledged ethnic cleansing effort, which further escalates fervor for the issue of ethnicity.

Meanwhile, the insurgency struggles to maintain a solid base of support as the legendary violence leads to increasing fervor, which leads to increased violence in a vicious cycle. An overwhelming majority of the populace opposes the government, yet the passion of the masses has prohibited the loosely ideologically aligned opposition from solidifying the insurgent force into a common coalition. Figure 3.15 depicts the results. Notice that the majority of the population outside the government's control regime remains extremely distributed across the population map. The dire situation has led to an extremely parochial mentality where nobody trusts each other. As a result, the insurgency

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maintains natural control of a small fraction of the population. Without the support of external facilitators, it cannot overcome the regime's military might despite the fact that it has a relative advantage in support.

In time, the ethnic cleansing will change the population map by either killing those in opposition camps or by forcing them into exile. In either case, the human toll will undoubtedly leave a scar upon the journals of history. Economically, the region will drain of foreign trade and investment and the instability born of the *Doulah* conflict will risk spreading like a contagion.

c.   *Light Footprint of Lethal and Non-Lethal Aid*

In this final course of action, NATO elects to support the rebels with limited military aid to include arms, training, and air strikes. Following the *Doulah* regime's failure to transition power following the mandated deadline, NATO quickly announces its support to the rebel cause.

NATO establishes sanctions on the regime and enforces a no-fly zone over *Doulah*. Additionally, it uses precision air strikes to neutralize the military's formations. The *Doulah* government can no longer rely on its superior military force to equalize the disparity in popular support. Moreover, the sanctions have greatly reduced its ability to recruit artificial control.

The opposition welcomes the indirect support of the NATO forces in its attempts to overthrow the oppressive regime. However, NATO careful makes its support contingent upon establishing legitimacy among the populace. In other words, NATO appreciates that the ethnic violence will not serve the interests of the inhabitants of *Doulah* or the international community. It requires that the opposition deescalate fervor for ethnicity by including *Aqleah* membership. NATO further ties its support to abstaining from human rights abuses, which tends to decrease fervor for concerns of equal protection. Conversely, the influx of foreign cash into the military effort increases concerns over the economy and fervor for free markets rises.
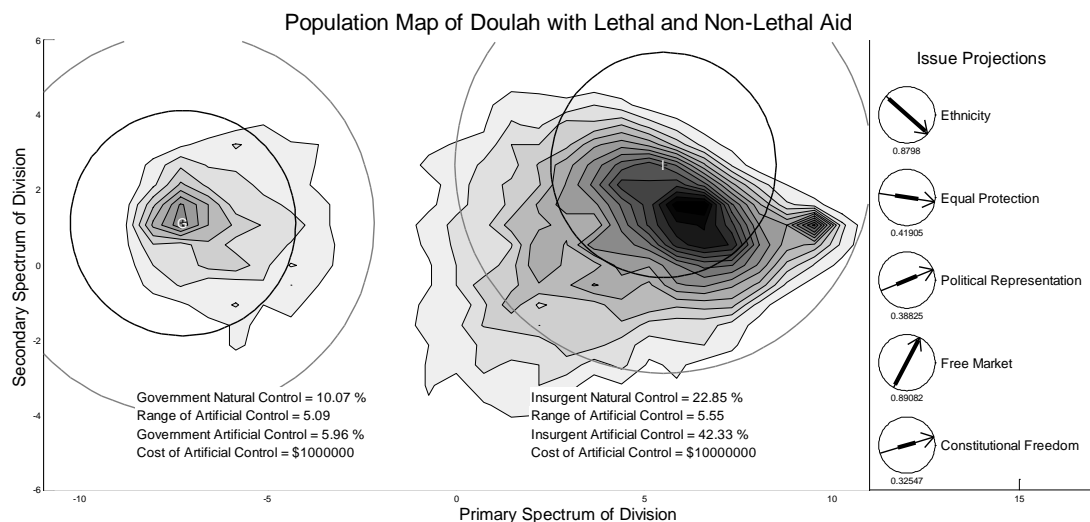
Figure 3.16   Population map of *Doulah* with lethal and non-lethal aid

Figure 3.16 displays the result of the new map with the decreased fervor for all issues except economics. The ebbing passion has allowed the insurgent coalition to coalesce around a common platform. Meanwhile, foreign financial aid allows the rebels to recruit a significant amount of assisted preference while military aid allows for the defeat of the regime's forces. In fact, as the rebel group displays greater legitimacy and gains popular momentum, some senior leaders within the military begin to defect.

In a few months, the NATO-supported rebels overwhelm the government's regime. The process of transition requires the legitimacy of the new government in order to decrease fervor for the issues that led to conflict. Decreasing fervor eventually brings the majority of the constituents back within the range of normal politics. In other words, almost everyone perceives their preference position to lie within a distance of 12 from everyone else. Having achieved this pivotal point, the transition government holds democratic elections.

D.   CONCLUSION

The situation in *Doulah*, though hypothetical, has many components of failed states from the past. The current situation in Syria, the fall into chaos that occurred in Iraq after the fall of the Saddam regime and the overthrow of Hosni Mubarak are just three of the many examples that helped shape the scenario in *Doulah*.

Doulah, as a system, highlights a few key truths that should be understood from a strategist's perspective. One is that determining the outcome of a conflict is not decided in advance, and the choices authorities make shapes the way coalitions form and act. This concept is supported by McCormick et al.'s main argument in "Things Fall Apart;" namely, that counter insurgents face a paradox that forces diminishing returns if they choose a heavy handed approach.[109]   Alternative methods are suggested by the population map to be more efficient when dealing with an insurgency, as depicted when comparing alternate endings one and three. Indeed, preventing internal wars through appropriate handling of coalitions is far more efficient in terms of national wealth than revolution.[110]   Scene three, alternate ending one (the heavy handed approach) validates McCormick et al. when they claim, "States generally pass a tipping point and enter their endgames and begin to decay at an accelerating rate. This is often an indicator that the final period of the struggle has begun."

Strategically, the third-party intervention in the second alternate ending was not quite as bad as the heavy handed approach for resolving the conflict, but it reminds one of the structural capabilities of a country to gain equilibrium within their own country. Given the third party intervention when only non-lethal aid was provided, the structure of *Doulah* was such that chaos will always ensue as long as the coalition believes that only an autocracy can rule over the people.

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[109] Gordon H. McCormick, Steven B. Horton, and Lauren A. Harrison, "Things Fall Apart: The Endgame Dynamics of Internal Wars," *Third World Quarterly 28, no. 2 The Long War: Insurgency, Counterinsurgency and Collapsing States* (Taylor & Francis, Ltd., 2007), http://www.jstor.org/stable/4017702 accessed on April 24, 2013, 321–367.

[110] McCormick et al., "Things Fall Apart,"

In alternate ending two, the model demonstrates the inability of the country to reestablish stability with endogenous resources. The structural ideologies of the constituents make the country susceptible to internal violence. Once fervor drives competing coalitions outside the range of normal politics, a vicious spiral ensues where violence provokes fervor which provokes violence. In this case, a third party interventionist is unlikely to break the cycle with non-lethal aid alone. The country will eventually solve its internal problems, but the human toll and regional impacts may impose an unacceptable cost to foreign interests. The model suggests that a more comprehensive approach would offer a better outcome.

The blending of lethal and non-lethal aid in alternate ending three gave a better outcome given the structure of *Doulah*. By avoiding an overt military presence, NATO avoided playing the role of the unwelcomed interloper. Yet, the contingent military support to the rebels allowed them to overcome the regime's military might in an expeditious manner. Shortening the duration of the violence prevented the escalation of fervor that scene two depicted. Simultaneously, tying the support to appropriate reforms allowed the rebel coalition to decrease fervor along key issues that divided the society. As the country transitions from the old regime to a peace under a new leadership, it is crucial that fervor decrease for contentious issues.

The model portrays the dynamics of the *Doulah* society in order to suggest why some strategies work while others fail. Most importantly, it characterizes the ideologies of the society as structural barriers. An interventionist should fully understand the ideological positions of the population that it seeks to influence. It can support the rise and fall of coalitions through careful manipulation of fervor. However, attempting to alter a society's ideology directly is a futile and counterproductive task.

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IV. CONCLUSION

Throughout this thesis the authors have sought to bring the complexities of societal equilibrium to light in a new way. By depicting population maps based upon political science, polling data, and technical collection data, the model utilizes the precepts of artificial and natural control to depict the amount of equilibrium within the society. Societies in disequilibrium will appear as a highly fractured map with very little of the population under natural or artificial control. Countries close to revolution will have one or more factions outside the realm of normal politics; such coalitions are willing to use violence to reform the government.

Understanding intrastate conflict was critical to this thesis in order to demonstrate to the reader how one could apply the model to revolutions. The map could theoretically be tailored for use at various levels of application; including, nesting grassroots collection methods into a single collective database that provides scalable population maps as a layer on a geospatial map for use at all levels of war. In such a manner the various networks that have remained dark might be illuminated with a new perspective overlaid upon them.

The thesis uses the first chapter to both introduce the concepts for population maps and define the most important terms. In the second chapter a thorough explanation of the model demonstrates the working components, in preparation for the third chapter. Chapter II depicts the components in a way that any reader can conceptualize. In Chapter III, the hypothetical country of *Doulah* demonstrates to the reader the power of the model, and how a decision maker might utilize it to bring about peace in the most efficient manner. While conflict and revolution are messy endeavors, better solutions will be available than in the past if leaders utilize information to its potential in the Information Age.

A. WEAKNESSES AND LIMITATIONS

While the model gives an objective portrayal of a society's political space, it does have limitations. Specifically, this work does not give consideration for the practical costs

of implementing the model. Additionally, the work does not address ethical considerations for manipulating fervor within societies. Finally, the model's use of fervor as a scalar that applies equally across ideology on a single spectrum may over-simplify real life.

The model has three caveats with regards to practical implementation. First, developing the proper polling instruments and capturing the utility curve of a society is not a trivial task. Second, the amount of data necessary to optimize the model might be extremely expensive. Third, it would take a networked software implementation of the model to utilize it at a meaningful level.

Considering the first point, the model has thus far assumed that a poll can accurately capture ideology and fervor as independent aspects of preference. Since this work did not examine the science of polling, it does not establish the feasibility of directly measuring fervor and ideology. Furthermore, an indirect measure might require a host of psychologists, whose results may or may not be prone to error. This work assumes that the model's user can obtain this data without providing any justification.

To the second point, the hypothetical examples in Chapter II and Chapter III assume a sample size of 10,000 respondents in order to give high resolution to the contour maps produced by the model. A survey of this magnitude would consume a great deal of resources in the United States. Conducting the survey in a decaying Third World country would be even more challenging. A survey of fewer respondents would still work as an input to the model, but the contour maps would not display the same level of relief. This work does not address the costs or feasibility of collecting this volume of data.

The third point, and last point regarding practical concerns, relates to the actual operational implementation of the model. Providing a functional model to the user requires a networked implementation. Appendix B constructs the model in MATLAB. While MATLAB is capable of demonstrating the dynamics of the model, it is a poor choice of software for a user-end product. Instead, a development team would need to recreate the model in a software platform capable of sharing networked data. Ideally, collection resources would sample the population and write the data directly to a server,

which the user-end software would interpret. The feasibility and methodology for achieving a functioning product is not covered in this work, but possible research topics for development are covered more under the future research section of this chapter.

The model is also limited in specifically explaining how to alter the population map by changing fervor. It suggests that changes in fervor cause the rise and fall of coalitions, and hence it suggests issues where a coalition might want to incite or quell fervor. Yet, it never addresses how to change fervor. This thesis work leaves changing fervor as an open question.

Consideration of the ethical implications of the model should be considered. For now, the model is unverified and untested. However, if the model ultimately has prescriptive power, one must consider its recommendations from an ethical perspective before proceeding with a decision. For instance, if the model suggests that the United States could benefit from increasing fervor in order to destabilize an unfriendly regime, then it must consider the ethical implications of inciting revolution before acting. Chapter III demonstrates the implications of increasing fervor to bring a society closer to revolution; the outcome categorically involves violence. The model intends to make users, and thus decision makers, more aware of second and third order consequences associated with manipulating the human terrain. However, the model does not directly address the ethics of manipulating the fervor of a society.

The model assumes that fervor impacts the political space as a uniform scalar for ideology. One might take objection to this simplification. For instance, the model assumes that an increase in fervor on the issue of deficit spending makes conservatives and liberals feel more distance between camps and within camps. Most would agree that an increase in fervor makes liberals feel more distant from conservatives. However, many would argue that increasing fervor causes a rallying around the party platform within a coalition. In other words, fervor does not scale as a linear function across the ideological spectrum. It makes enemies feel more distant while simultaneously rallying allies around a tighter platform. The population map could certainly account for this contingency.

However, it would increase the complexity of the model and it would require a greater volume of polling data. At this point, it is not clear that the benefits of complicating the model with non-linear scaling justify the costs.

Verifying and validating the model could be achieved by two means: practical application and academic methodology. One way to verify and validate the model is a comprehensive study that includes developing a fully functioning model and practical application, collecting data for a specific population map, and generating a working product. Another way is to collect historic data in an academic approach. The academic approach would require the researcher to collect data from a wide range of sources.

The former method, though more accurate for practical purposes, would be highly resource intensive without a working prototype. The latter would server the next academic step, ensuring the rigors of research have tested the methodology before practical employment. The academic approach would require an ample amount of research to find objective data that could be inputted into the model, and then an equal amount of time determining how to appropriately place it into the model. The practical application's advantages include data tailored to the map from the outset. The authors believe both methods will return the desired results, however resource constraints may prevent a working model from being built before the rigors of academic verification are placed against the theory.

B.   FUTURE RESEARCH

In order to operationalize the model two components are essential. The interface for the model needs to be researched and developed. Initial thoughts on the best platform include HTML5, due to its video graphic capabilities and interoperability across the global Internet. Since HTML5 is relatively new, it should endure long enough to make the initial versions of the model viable. The model's interface should allow the analysts to filter for specific issues and generate simulated outcomes based upon information inputs. For instance, if the fervor for gun control is currently high, then the analyst could run simulations that provide the optimal outcome for his or her agenda based upon the

spiking of the other relevant issues in the society. Other tools need to be developed as needs arise; so, the operationalized model needs to be adaptive enough to accommodate plugins, add-ons, and upgrades.

While the focus of the work has been primarily on the working model, the importance of how the information is collected has not been wasted on the authors. Collecting, inputting, and categorizing the data from a real country or polity could be as large (more accurate) or small (less accurate) as the analyst desires.

Future research on data collection should include methods of collection. In order to properly tailor the data to the population, the data collection manager needs to scrutinize primary sources of information flow within the society. For example, a flourishing first world country theoretically needs a more robust collection matrix than a deteriorating third world country.

Collection efforts in the first world country may include, but are not limited to, Internet scraping, door to door polling, phone polling, text polling, and other efforts that seek to capture the demographics of the area.

A third world country may only have limited Internet access, thus Internet scraping may only yield pertinent international issues, rather than intrastate issues. Furthermore, if only the youth of the nation have phones, then door to door polling may be much more effective than text or phone polling. Tailoring the collection effort to the culture is unique to the model. Demonstrating its robust nature, the model is highly adaptive to cultures, while still maintaining its objectiveness.

One particularly unique area of study would be the integration of local and national narratives being written by academics throughout the country and the influence those messages have on the population at large. The research line would include transferring the narrative into an objective value that could be used universally across cultures to determine the numerical input into the model. For example, a leading national scholar believes that readily available electricity for every citizen is essential to making the disparate more socially equally to the affluent. While the model does not currently have a way to objectify the narrative, the message certainly has value for which the

model should account. A dedicated research line to narratives for input into the model would find fertile ground for thought and prose. Other collection efforts include information from the intelligence community, local and national news outlets, expatriated citizens living abroad and their fervor for issues, to name a few.

Inputting the data would be a tiresome endeavor without automated software for Internet collection. Therefore, the data collection manager should have a comprehensive plan to develop the software necessary to synchronize the model and data input. Accordingly, electronic collection devices should replace the old methods of collecting door to door polling with analog ledgers.[111]   The transition allows polling officials to collect and input data simultaneously.

When the software for the model is developed, the method of input is possibly the most vulnerable to poor planning and execution. Earlier, the future research section discussed the means of operationalizing the model. The data input should have zero personal input that requires a paper transmission to digits. In the Information Age, redundancy leads to time loss and a higher incidence of mistakes. The data input methodology should be as autonomic as possible, with the exception of the required bodies to run software, knock on doors, and make phone calls.

Categorizing the data, similar to inputting the data, should also be nearly autonomic. Statistical programs based upon sound polling techniques and science lay the foundation for the categorization of the data. This work has not focused its efforts on collecting the data; however, the methods must account for statistical spreads with appropriate mathematical principles in order to achieve accurate results and error estimates. Programs and applications must integrate into the collection, and the operationalized model needs to automatically filter, detect, and categorize the data for near-real-time results.

As this work has shown, the elements of fervor and ideology interact in powerful ways that impact the stability of a nation-state. The model implies that observers gain an

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[111] Note that this statement does not argue against door-to-door polling. Instead, it suggests that the pollster ought to collect the data in a usable electronic form.

understanding of the relative coalition unity or disjointedness for ideological issues. That, in and of itself, provides the situational awareness that key leaders demand for making well-informed choices, but ultimately falls short of the model's potential.

An equally important aspect of the model is the domestic communication process. The process is necessary to reach the targeted population for two reasons; one, to inform them of the issues, and two to incite or deescalate fervor. The population map depicts the strategic effects caused by the rise and fall of fervor for ideological positions in the form of coalition distance; however, to leverage the power of the model in a proactive manner, the end user must have a firm understanding for trusted and available means of messaging that penetrates to the targeted populace. The modeler uses indigenous lines of communication to employ his strategies. The careful application of strategic moves controls the political space by adjusting fervor to influence ideology and thereby change the preferences of coalitions.

The indigenous communication infrastructure must be examined to maximize messaging contact with greatest number of citizens. The means by which the society receives, accepts, and transmits information within a nation-state is crucial knowledge to the user. Ideological positions may be partially inherited through individual and community identities, but the introduction of competing ideology remains an option. All nations have established forms of communication that pass along information of importance and influence across the fabric of society. It is through the unique national communications platforms and methods that the citizens receive their information. Utilizing the established media outlets directly influences the society's ideological positions and fervor for issues greater than the introduction of an untrusted platform.

Future research topics should seek to answer questions surrounding the indigenous communication aspect of the model. Is there generally a point at which frequency of messaging or communication reception sustains fervor? Will too much frequency desensitize the receiver? Or, will it enhance or diminish fervor? Assumptions should not be made but rather tested to establish some basic norms about what is required to effectively manipulate levels of fervor through a comprehensive communication design to best capitalize on the model.

Frequency of contact plays a part in manipulating fervor and informing the constituency about the ideological issues of the day. The impact that frequency of contact has on the level of societal fervor is an area of future research. Its effects need to be determined to determine the efficacy of messaging to adjust the population map. Current software, like Lighthouse[112], could be an excellent source of data. The next academic line of research for population maps should include a software model for mapping that can easily communicate with Lighthouse and other data collection software platforms. The use of mobile platforms as the main mode of mapping should be considered, since data collection and projection are likely to have the most success over the Internet due to the vast amounts of data that can be collected.

C.   CONTRIBUTIONS OF THE MODEL

Mathematically modeling social equilibrium contributes to social movement theories. The model serves defense analysis in two important ways. First, it advances current theories by providing an objective model of the waning and waxing of coalitions. The methodology explained provides a foundation for testing and applying the precepts proposed by other experts of intrastate conflict. Second, the model introduces the concepts of preference, as a function of ideology and fervor, and the range of normal politics into the discussion of social movement.

The population mapping model makes a distinction between ideology and fervor as unique, yet related, aspects of preference. Doing so gives insight into how societies mobilize behind coalitions. The model suggests that strategies should consider ideology as rigid structural constraints. Based upon the theoretical components of this model, attempts to mobilize societies by altering ideology are likely to fail or prove prohibitively

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[112] "Lighthouse is a software application created by the Common Operational Research Environment (CORE) Lab at the Naval Postgraduate School, Monterey, CA. The application they created allows users to enter socio-cultural information into a smart phone or tablet. Lighthouse takes pages of code and provides a user-friendly interface for collecting data in the field. It then exports the data into analytical software packages that visually depict relationships between individuals, revealing social networks. Lighthouse facilitates the visualization of a complex operational environment for either a commander or an operator on the ground." The application has been tested by U.S. Army Special Forces units operating in Afghanistan. Kenneth Stewart, "NPS' CORE Lab Rethinks Traditional Intelligence Analysis," Naval Postgraduate School, September 13, 2012, http://www.nps.edu/About/News/NPS-CORE-Lab-Rethinks-Traditional-Intelligence-Analysis.html (accessed May 16, 2013).

costly. Instead, a strategist can achieve the desired effect by manipulating the fervor of the society. To do so successfully, one must first understand the human dynamics of the population. The population map gives a cartographic view of the human terrain so that the strategist can quickly understand how to influence the political space through fervor—a dynamic force that is easily influenced by targeted messaging.

This methodology introduces the possibility of objectively testing many theories revolving around the human domain of conflict. Most of the current models, provided by experts on intrastate conflict, rely on subjective assessments. Therefore, it is difficult to test the validity of their models until after conflicts are over. This work has built other's work into a discrete mathematical model, which offers insight into the validity of previous theories.

Newly introduced, the range of normal politics is a domain past artificial control. This work makes a meaningful distinction between the two. Artificial control, as used by this work, denotes support that a coalition purchases through side payments. The process of acquiring artificial control is a strategic decision made on the part of a coalition. The range of normal politics differs in that constituents outside the reach of control (both natural and artificial) but within the range of normal politics will oppose the ruling coalition, but only through sanctioned methods as defined by the laws of the state. A ruling coalition can alter the range of normal politics in two ways. First, it can increase the cost of conflict (e.g., using secret police to punish descent). Second, it can amend the law to allow greater opportunities for sanctioned dissent. This course of action changes the utility curve by decreasing the costs of supporting a coalition.

D.   CLOSING

As it stands, this model presents an untested paradigm for quantifying the human aspect of conflict in the form of a population map. Anecdotally, it displays the dynamics of the formation and dissolution of coalitions well by starting with a trivial truism: coalitions enter into conflicts within a state as a consequence of divergent preferences. This tautology begs the question: what makes up the preferences of a constituency? The model of the population map suggests that ideology and fervor are the components of

preference. It then investigates how to achieve strategic objectives by eliciting the rise and fall of coalitions through changes in fervor as opposed to ideology.

In an era of persistent conflict where the United States' Department of Defense must do more with less, this tool hopes to offer insight into efficient strategies for achieving objectives. Perhaps more importantly, it suggests the counterproductive nature of employing strategies contingent upon changing ideologies through direct intervention. Whether applied to Unconventional Warfare, Foreign Internal Defense, Stability Operations, or a host of other issues germane to the warfighter, understanding the human terrain is paramount to success. This thesis seeks to increase the warfighter's situational awareness by providing a population map.

APPENDIX A: THE MATHEMATICAL MODEL

The following appendix gives a rigorous mathematical explanation of our model. It explains the model in two steps. First, it uses survey data in the form of ideology and fervor matrices to generate a preference matrix for a constituency. Second, it uses the preference matrix to analyze the strength of coalitions within the constituency given the ideological platform of the coalition, the coalition's budget for artificial control, and the utility function for the constituency.
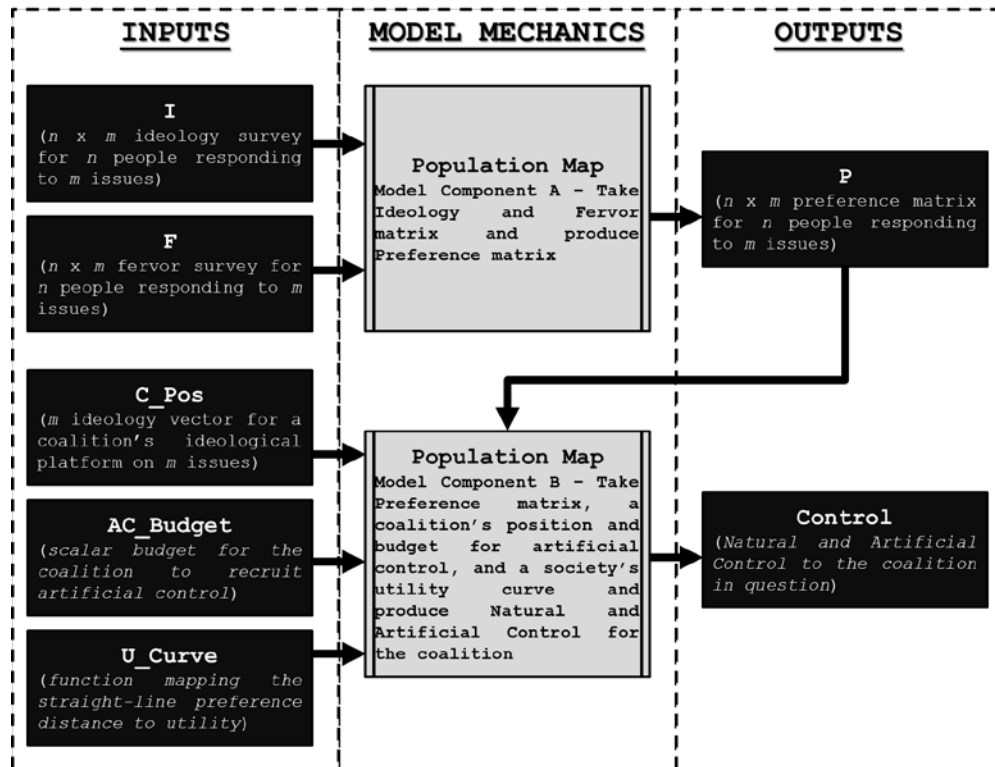
We justify the logic driving the equations and relationships in Chapter II. This appendix will remind the reader of Chapter II's conclusions without offering a thorough justification. It will trace the logic of the model from the start to finish. In doing so, it will jump from describing the theoretical math to the practical implementation.

Our implementation of the model occurs in MATLAB. Appendix B includes all of the code to run simulations, generate hypothetical survey data, and produce the figures

contained in this work. The model lends itself to numerical methods since it uses discrete survey data. Whenever possible, we generalize the model to accept continuous data as well.

A.   GENERATING THE PREFERENCE MATRIX

In order to generate the preference matrix, **P**, the model uses the survey data in the form of two *n* x *m* matrices where *n* is the number of respondents polled and *m* is the number of issues polled. In other words, each respondent represents a row of the matrix and each column represents an issue. One matrix contains the survey results for the ideology of the respondents while the other contains the fervor. We will call these matrices **I** and **F**, respectively. Each value in **I** ranges from -1 to 1, corresponding to complete opposition for the ideology in question to complete support for the ideology in question. Each value in **F** is simply greater than or equal to zero, corresponding to the passion or fervor that the respondent feels for the issue. A zero denotes complete indifference for the ideological position (e.g., given a trivial issue, one has an ideological position, but no fervor for promoting or defending the position). A high number (as determined by the limits of the poll) denotes fanatical devotion for the ideological position (e.g., a religious zealot might be willing to kill those who do not share their religious ideology).

$$F = \begin{bmatrix} f_{11} & \cdots & f_{1m} \\ \vdots & \ddots & \vdots \\ f_{n1} & \cdots & f_{nm} \end{bmatrix} \mid f_{ab} \in \mathbb{R} \geq 0$$

$$I = \begin{bmatrix} i_{11} & \cdots & i_{1m} \\ \vdots & \ddots & \vdots \\ i_{n1} & \cdots & i_{nm} \end{bmatrix} \mid i_{ab} \in [-1, 1]$$

Now, our preference matrix, **P**, is a function of **I** and **F**. As justified in Chapter II, we use the mean fervor of the population for each issue to scale **I** in order to arrive at **P**. Simply put, **P** is **I** scaled by the column means of **F**. To scale the ideologies, we first generate $\bar{\mathbf{f}}$, the column means of **F**.

$$\bar{f} \in \mathbb{R}^{1xm} \geq 0 \mid \overline{f_a} = \frac{\sum_{b=1}^{n} f_{ba}}{n}$$

With $\bar{\mathbf{f}}$ thus defined, we can generate $\mathbf{P}$ as follows.

$$P = \begin{bmatrix} p_{11} & \cdots & p_{1m} \\ \vdots & \ddots & \vdots \\ p_{n1} & \cdots & p_{nm} \end{bmatrix} \mid p_{ab} = i_{ab}\overline{f_b}$$

Now, we have our preference matrix, $\mathbf{P}$, which is an n x m matrix corresponding to the preferences for each respondent for each issue (again, respondents correspond to the rows and issues correspond to the columns). We assume a great deal about the fidelity of the poll as we move onto the next step where we use $\mathbf{P}$ to display the inner dynamics of coalitions in a contest for power.[113] At the most basic level, we assume that $n \ggg m$. Therefore, as we consider the rank of $\mathbf{P}$, we are most interested in strongly correlated issues and we can assume that m bounds the rank of $\mathbf{P}$.[114]

B.   USING THE PREFERENCE MATRIX AS A POPULATION MAP

The next step in the model gives the user some options for how to employ $\mathbf{P}$, the preference matrix. By itself, the preference matrix can simply give a distribution of the population's preferences for any given issue or any combination of issues. Furthermore, principal component analysis gives insight into how correlated issues actually shape the political space of the constituency by reducing multiple issues onto a contour map.   In this map, elevation represents the density of issue-aligned constituents. This serves as a paradigm for the second component of the model, which gives proportions of artificial and natural control for a coalition given its ideology, budget, and the society's utility curve.

1.   A Density Curve for an Issue

The preference matrix in itself can yield the density of the population supporting a given issue. The figures in Chapter II illustrate the concept in one dimension where the

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[113] We do not intend to suggest how to conduct a proper poll. However, the poll must ensure that the scale of fervor correctly corresponds to the utility function and that ideology for issues maps as a linear relationship from -1 to 1. At a more basic level, the poll must sample far more people than issues in order to draw any meaningful conclusions about a constituency's preference for any given issue.

[114] We are interested in the rank of P because we expect that many issues have strong correlation to other issues.

horizontal axis denotes the preference position and the vertical axis denotes the proportion of the population supporting that preference position. Getting this distribution from **P** requires a little work.

P has only the scaled survey data. To generate a distribution from **P**, we start with a discrete vector for the issue in question. Call this vector **i_curve** since it will store the ideology curve for the issue. Obviously, we must decide upon the dimensions of **i_curve**, which will affect the resolution, *res*, of the curve. We use *res* to determine the interval for which to group respondents of similar ideologies. In other words, as we take the polling data and build a curve from individual responses, we need to decide upon the range of responses that we consider identical. This allows us to group similar responses into identical bins. In general, $2res^{-1}$ should be much less than *n*, the number of poll respondents, $2res^{-1} \in \mathbb{Z}$, and *res* should be greater than or equal to the resolution of the ideology responses polled. For instance, if the poll rates ideology from negative one to one in intervals of one-tenth, then *res* must be one-tenth or greater.

Now, we wish to map the ideological responses from [-1, 1] to [1, $2res^{-1} + 1$]. If *res* equals the resolution of the ideology responses of the poll, this is a direct mapping without losing any fidelity in data. For instance, consider that *i_pos* is the ideological position of the respondents ranging from -1 to 1 in intervals of *res* and we seek to map these responses to *i_rank* $\in$ [1, $2res^{-1} + 1$].

$$i\_rank = \frac{i\_pos + 1}{res} + 1$$

To generalize this equation to cases where *res* is greater than the resolution of the poll, we simply round the first term on the right hand side of the equation down to the next integer.

$$i\_rank = \left\lfloor \frac{i\_pos + 1}{res} \right\rfloor + 1$$

Now, we can generate **i_curve** by assigning an *i_rank* to each respondent's *i_pos* and incrementing the corresponding index of **i_curve** by 1/*n*. This gives a distribution of the population according to ideology. We best illustrate the methodology to generate **i_curve** by using pseudo-code.

```
for i=1:(2/res+1)

        for j=1:n

        if (i==⌊(i_pos[j]+1)/res⌋+1)

                i_curve[i]=i_curve[i]+1/n

        end if

        end for

end for
```

To get the preference curve (**p_curve**) from **i_curve**, we simply take the vector-scalar product of the ideology curve times the mean fervor for the given ideology.

$$p\_curve = \bar{f}(i\_curve)$$

Generalizing this process for each issue in the survey data yields a preference density matrix of dimensions $2res^{-1} + 1$ by *m*. Call this matrix **P_Curve**. At the most basic level, we can use **P_Curve** to give some graphical interpretations of the survey results. However, we can get much more meaningful data from analyzing the raw data in **P** before compiling it into density curves.

2. Issue Interactions

In one dimension, we obtained a density curve by mapping the ideologies of constituents into an array index for the ideology curve. We then multiplied by fervor to get the preference curve. Following a similar process gives issue interaction plots for two issues. This yields a preference surface where the two minor axes represents the preference positions for the issues and the major axis represents the proportion of the population supporting that combination of preference positions.

The methodology follows the logic delineated above for generating the preference curve. This time, we must sum across both indices. We illustrate the process using **I**, the ideology matrix. Assume that we want to look at the interaction of issues a and b, where $a, b \in \mathbb{Z}^+$ and correspond to the index of the issue that we wish to consider. The following pseudo-code produces **P_Int**, a $2res^{-1} + 1$ by $2res^{-1} + 1$ matrix containing the density surface for the population supporting a given interaction of issues a and b.

```
for p=1:n

        for i=1:(2/res+1)

        for j=1:(2/res+1)

                if (i == ⌊(I[i,a]+1)/res⌋+1) &&

        (j == ⌊(I[i,b]+1)/res⌋+1)

                P_Int[a,b]=P_Int[a,b]+1/n

                end if

        end for

        end for

    end for
```

As it stands, **P_Int** actually contains ideology interactions. To get the preference interactions we scale by the fervor.[115]

Plotting **P_Int** onto a contour graph will give issue a along one minor axis, issue b along the other minor axis, and the proportion of the population supporting the given population of the combination of issue a and b on the major axis (displayed as the contour on the graph). We use this methodology to look at the interaction of two issues

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[115] We choose to group by ideology first and then scale by fervor (as opposed to grouping by preference, which is already scaled) due to error and computational considerations associated with discretization. Whereas we know that our ideology scales from -1 to 1 and that res-1 $\in \mathbb{Z}$, we cannot say the same about $2 \max|p| \, res^{-1}$. Therefore, it is easier to group by ideology first. See the MATLAB code for more information.

throughout this work. Yet, the idea generalizes further to look at more than two issues with the help of linear algebra and principal component analysis.

3.   Principal Component Analysis

Principal component analysis (PCA) gives the model great analytical power. Chapter II describes how many issues break down into liberal versus conservative ideologies in the American political system. If a person holds a strongly conservative ideology on one issue, then one would expect them to have conservative ideologies on other issues as well. From a statistical standpoint, we would say that these issues have strong correlation. In other words, the variation of responses to one issue greatly explains the variation of responses to the other issue.[116] As a result, if we want to understand the American political space, we do not have to ask an exhaustive list of questions. We can focus on a few key issues that divide respondents into camps of conservatives and liberals across a narrow range of spectrums (e.g., economic and social). For less understood political systems, we can rely on linear algebra to reduce correlated issues into a single spectrum in the same manner.

We work with PCA to reduce the dimensionality of $\mathbf{P}$ from m, the number of issued polled, to two. This allows us to plot the best approximation of the population's preference distribution onto a two dimensional map. Conceptually, we can revisit the American political system and imagine a pollster asking a thousand questions. As he aggregates the data, he cannot graphically depict a thousand issues on one plot. Breaking the data down into its first two components might separate the spectrum into two axes: economic liberals to conservatives and social liberals to conservatives. The benefit of the new map is that it plots onto a single graph, allowing one to quickly conceptualize the American political space. The cost of the graph is fidelity of the data. The map loses some information in reducing the dimensionality of the political space from m equals one thousand to m equals two. However, as we will investigate, this loss in information is acceptable for our purposes.

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[116] Dennis D. Wackerly, William Mendenhall III, and Richard L. Scheaffer, *Mathematical Statistics with Applications, 7th edition* (Belmont: Thomson, 2008), 264–5.

To illustrate the concept, consider Figure A.1. Here, we start with only two issues (issue A and issue B). The graph in the upper right depicts a scatter plot of fifty respondents in Figure A.1.A. One can quickly see that correlation exists between the issues. Those who tend to support A also support B. Even though two issues exist, most of the variation in response occurs along the first principal component (or PC1 in the graph). Once we measure variations along PC1, we can explain the remaining variation along PC2. Note that PC2 is orthogonal to PC1. This is always the case in PCA. In fact, PCA creates an orthogonal basis for the column space of the data matrix.
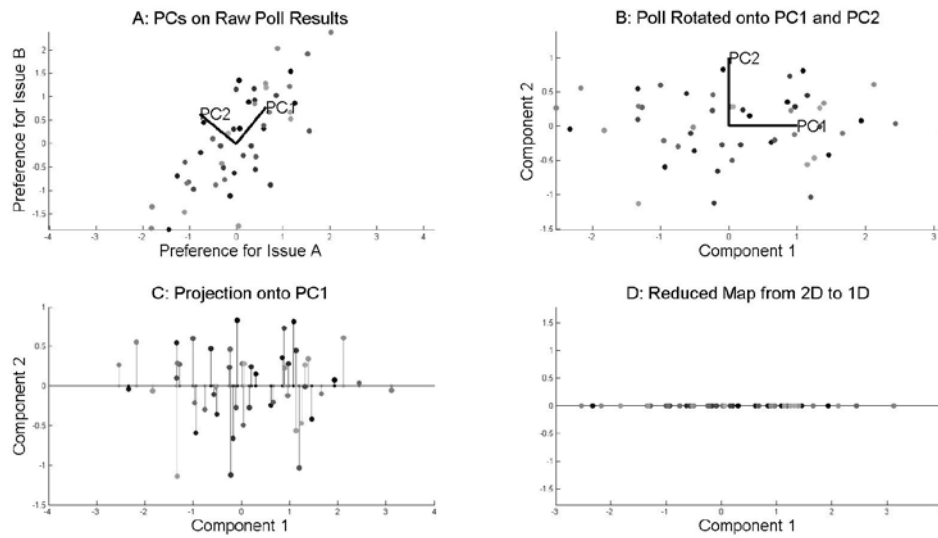
Figure A.1   Graphical example of PCA to reduce two dimensions to one

Following Figure A.1, we now rotate the data to place the components as the axes instead of the issues in Figure A.1.B. A careful inspection of the scatter plot will reveal that the top right plot (Figure A.1.B) is simply a rotated image of the graph on the top left (Figure A.1.A). Note that we started with $m = 2$. That is, we had only issues A and B. Therefore, when we look at these two issues on the components, we have an exact copy of our original data. This is not the case when $m > 2$. To illustrate this concept, we consider the bottom two graphs of Figure A.1.

To reduce a data matrix from m dimensions to two dimensions, we must project the m-dimensional data onto component one and two of our PCA. This is extremely difficult to conceptualize for data sets when $m > 3$ since we have trouble visualizing data in greater than three dimensions. Figure A.1 displays a reduction from two dimensions to one dimension in order to offer insight into the process. Note that the bottom left graph (Figure A.1.C) is an exact copy of the top right graph. In other words, it is a scatter plot of the respondents' preferences for issue A and B rotated according to the first and second components of PCA. However, in the bottom left graph (Figure A.1.C), we project each point from two-dimensional space onto the one-dimensional PC1. We can see that we project a point from the two-dimensional PC1 and PC2 onto one-dimensional PC1 by drawing a line through the data point orthogonal to PC1. Now, we have an approximation of our two dimensional data in one dimension (Figure A.1.D). PCA ensures that our simplification maintains as much data as possible. In other words, we lose the ability to discriminate along PC2 when we project our data onto PC1. Yet, no other projection would preserve as much of the original data as the projection we chose according to PCA. The bottom right graph (Figure A.1.D) depicts this reduced map. We preserve as much information from the original data matrix as possible, but have reduced the dimensionality of our data set from two to one. Our map takes any number of issues and reduces the dimensional space from m to two in order to graphically depict political space. Moreover, although the projection loses some fidelity of the data set, it offers the best possible simplification of a multi-dimensional **P** matrix into two dimensions.

The first step of PCA is to center the data. In other words, we simply subtract the column means from **P** so that our expected value for any preference position is zero.[117] This benefits the generic interpretation of the data. For instance, consider an issue that most people support, like free speech in the United States. If we took a poll of the ideological positions for supporting free speech, we would probably find that most Americans rate their position closer to positive one (i.e., they ideologically support free

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[117] Herve Abdi and Lynne J. Williams, "Principal component analysis," *WIREs Comp Stat 2, no. 4* (2010), 433–459.

speech). Subtracting the mean ideology from each response centers the data so that those who relatively oppose free speech appear left of center, with zero representing the center's ideological position.

Many implementations of PCA then normalize the column data by dividing by its standard deviation. This standardizes the data so that differences in the scale of measurement do not artificially weight one data column over another. As an example, if our survey asked people to rate their fervor on a scale of one to ten on one issue and then rate their fervor on a scale of one to one hundred on another issue, a moderate population would rate the first at five and the second at fifty. The PCA would weigh the issue with the larger scale as more important even though the population shares moderate fervor for both issues.[118] In our case, we do not want to standardize our data because we presume that the method of sampling has used a consistent scale. Therefore, if one issue has larger variance than another issue within $\mathbf{P}$, it is because the issue is more divisive. Hence, we want PCA to weight this issue more heavily.

Once we subtract the column means from $\mathbf{P}$ so that the expected value of each column is zero, we have a centered the preference matrix. With $\mathbf{P}$ centered, we next conduct a Singular Value Decomposition (SVD) of our centered data matrix in order to arrive at the principal components. Let $\mathbf{X}$ equal the centered matrix $\mathbf{P}$. SVD seeks to solve the problem $\mathbf{X} = \mathbf{U}\mathbf{\Sigma}\mathbf{V}^*$, where $\mathbf{X} \in \mathbb{R}^{n \times m}$, $\mathbf{U} \in \mathbb{R}^{n \times n}$, $\mathbf{\Sigma} \in \mathbb{R}^{n \times m}$, and $\mathbf{V} \in \mathbb{R}^{m \times m}$. In this case, $\mathbf{V}^*$ is the conjugate transpose of $\mathbf{V}$. Both $\mathbf{U}$ and $\mathbf{V}$ are unitary (i.e., their columns are orthogonal to each other).[119]

To solve this, we note that $\mathbf{X}^* = (\mathbf{U}\mathbf{\Sigma}\mathbf{V}^*)^* = \mathbf{V}\mathbf{\Sigma}^*\mathbf{U}^*$. Now, $\mathbf{X}\mathbf{X}^* = \mathbf{U}\mathbf{\Sigma}\mathbf{V}^*\mathbf{V}\mathbf{\Sigma}^*\mathbf{U}^*$. Since $\mathbf{V}$ and $\mathbf{U}$ are unitary, we get the identity matrix when we multiply them by their complex conjugate. Hence, we are left with $\mathbf{X}\mathbf{X}^* = \mathbf{U}\mathbf{\Sigma}\mathbf{\Sigma}^*\mathbf{U}^*$. We note that this is the exact form of an eigenvalue decomposition of $\mathbf{X}\mathbf{X}^*$. Since $\mathbf{\Sigma}$ is diagonal, $\mathbf{\Sigma} = \mathbf{\Sigma}^*$. Hence, $\mathbf{\Sigma}\mathbf{\Sigma}^* =$

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[118] Julian J. Faraway, *Linear Models with R* (New York: Chapman & Hall, 2005), 134.

[119] Lloyd N. Trefethen and David Bau III, *Numerical Linear Algebra* (Philadelphia: SIAM, 1997), 25–30.

Σ^2, which is also a diagonal matrix.[120] Furthermore, since $\mathbf{XX}^*$ is a symmetric matrix, its eigenvalues are all real and positive.[121] The column space of $\mathbf{U}$ now corresponds to the eigenvectors of $\mathbf{X}$ and the diagonal of Σ corresponds to the eigenvalues. Therefore, simple eigenvalue decomposition gives us $\mathbf{U}$ and Σ. To get $\mathbf{V}$, we solve for $\mathbf{AV} = \mathbf{U}\Sigma$.[122]

As a convention, we place our largest eigenvalue in $\Sigma_{1,1}$ and then fill the diagonal with descending values. The result ensures that $\mathbf{v}_1$, the first column vector of $\mathbf{V}$, is the right singular vector corresponding to the largest eigenvalue of $\mathbf{X}^*\mathbf{X}$.[123] Now, $\mathbf{v}_1$ is equal to the first component of PCA. Similarly, $\mathbf{v}_2$ is equal to the second component. For the purposes of our population map, we only need the first two components in order to reduce $\mathbf{P}$ from m dimensions to two dimensions.

Let $\mathbf{R}$ be the reduced two dimensional image of $\mathbf{P}$. Note that $\mathbf{R} \in \mathbb{R}^{n \times 2}$. We can build $\mathbf{R}$ using $\mathbf{P}$ and $\mathbf{V}$ as follows. Let $\mathbf{r}$ equal a row vector of $\mathbf{R}$ and let $\mathbf{p}$ equal a row vector of $\mathbf{P}$. Note that $\mathbf{r} \in \mathbb{R}^m$, $\mathbf{p} \in \mathbb{R}^m$, and $\mathbf{v} \in \mathbb{R}^m$. To solve for $\mathbf{r}$, we project $\mathbf{p}$ onto the first two columns of $\mathbf{V}$ (components one and two), which we will call $\mathbf{v}_1$ and $\mathbf{v}_2 \in \mathbb{R}^m$.

$$r_{i,j} = \text{proj}_{\mathbf{p_i}} v_j = \frac{p_i \cdot v_j}{\|v_j\|}$$

Now, $\mathbf{R}$ holds our reduced preference matrix, which we can display in a cartographic map. To do this, we use the methodology described in plotting an issue interaction. We use $\mathbf{R}$ as the matrix from which to plot the interactions and the result is the best possible representation of an m dimensional population that we can fit onto two dimension and plot on a flat piece of paper.

4.   Accuracy of the Reduction

As discussed, reducing m issues in a population to two issues allows a cartographic depiction of the population's preference density. Hence, it gives the user a

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[120] Francis Giraldo, "Singular Value Decomposition," class notes for MA3045, Naval Postgraduate School, Fall 2011.

[121] Steven J. Leon, *Linear Algebra with Applications, 8th edition* (Upper Saddle River: Pearson, 2010), 359–360.

[122] Giraldo, "Singular Value Decomposition."

[123] Trefethen & Bau, *Numerical Linear Algebra*, 26.

snapshot of the political space of the country. However, this reduction through PCA comes at a cost of fidelity. Inspecting the eigenvalues of **X** gives insight into the loss of information.

We can make a subjective assessment of the error in our approximation by using the scale of the eigenvalues. The **Σ** matrix contains the eigenvalues of **X** along the diagonal in descending order. Plotting the square root of the eigenvalues as a function of their diagonal index provides a quick methodology for gauging the loss in information due to projecting an *m* dimensional space onto two dimensions.[124] In general, if the eigenvalues corresponding to the third component is much smaller than the eigenvalue corresponding to the second component, then we can assume that we have captured most of our information. In other words, if $\lambda_a \lll \lambda_2$ for $a > 2$, we can empirically accept our two dimensional projection as a good representation of the true *m* dimensional data. In our plot, this would appear as an 'elbow' at an index of two or three (i.e., the line dramatically decreases from one through three and then levels off at the 'bend' to a value much less than the value for the first two indices). The elbow in the plot indicates that all subsequent eigenvalues correspond to components that explain little of the variance in the dataset. Hence, we can capture the main dynamics without considering components for small eigenvalues.[125]

We can also quantify the error. For example, we can use the singular value decomposition to reconstruct **X** (i.e., the centered **P** matrix). Let **Y** equal our approximation of **X** and note that $\mathbf{Y} = \mathbf{U\Sigma V}^*$ where **V** and **U** now only correspond to our first two rows of **V** and our first two columns of **U**. Clearly, $\mathbf{\Sigma} \in \mathbb{R}^{2 \times 2}$. **Y** should approximate **X**, but to objectively quantify how well it approximates **X**, we use the Frobenius matrix norm to solve for error in the equation below.[126]

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[124] We do not have to use the square root; we could instead simply plot the eigenvalues against their indices. However, using the square root tends to exaggerate the bend in the elbow, making a subjective assessment easier.

[125] Faraway, *Linear Models with R*, 137–138.

[126] Giraldo, "Singular Value Decomposition."

$$error = \frac{\|X - Y\|_{fro}}{\|X\|_{fro}}$$

Figure A.2 displays error for the population map of the United States (used in Chapter II) and the population map of *Doulah* (used in Chapter III).[127] The line plots the strictly decreasing square root of the eigenvalues against their diagonal indices in Σ. As described above, we look for the elbow in this plot to ascertain how many eigenvalues we need to capture most of the data. In the United States map, we do not see a characteristic elbow. Moreover, we see that the eigenvalues for indices greater than two are not orders of magnitude smaller than the values for λ_1 and λ_2. It follows that this projection has a large error (i.e., 57.3 percent) as calculated by the Frobenius norm. The plot for the projection of the *Doulah* population shows an elbow at three. We expect lower error than we found for the United States projection. The objective result of 25.3 percent error confirms this.
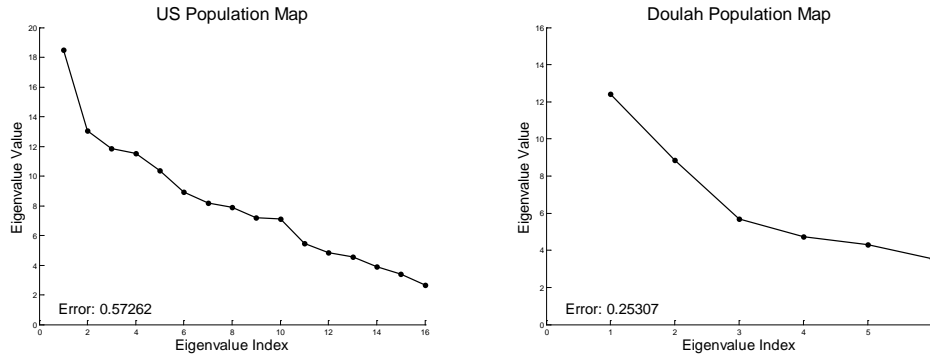
Figure A.2   Plots of eigenvalues of various population maps

We should note that error is not a major concern for the population map model. In the example above, both populations exhibit significant error in simplifying the data set down to two dimensions. Typical cartographers face the same challenge in finding the best projection as they attempt to map a three dimensional globe onto a two dimensional sheet of paper. Like the cartographer's map, our map is only a model from which to develop a quick understanding of the population's dynamics. Using PCA, we obtain the

---

[127] These error calculations are for the initial data sets (i.e., before any changes in fervor).

best simplification possible so that a human can view the political space of a constituency. Yet, the methodology for finding a coalition's control based on the population data maintains the full fidelity of the *m* dimensional data. Hence, even large errors in projections will not impact the results of the strategies suggested by this model. The model uses the concept of natural and artificial control to suggest strategies.

C.   FINDING CONTROL

The methods described thus far only give us a graphical display of objective survey data. However, we can infer greater information from the map by incorporating the utility curve for the society. This utility curve maps perceived distance to utility for the aggregate of the society. We will call this one dimensional function $u(x)$ where x denotes the Euclidean distance and $u(x)$ denotes utility. As a convention, we refer to dollars per month as the unit of measure for utility.[128]

1.   The Utility Curve

The general concept assumes that a constituent's expected utility for supporting a coalition decreases as he or she moves further from the coalition's ideological position along the preference surface. In other words, if Alice is a constituent and she considers supporting coalition B, she will evaluate her expected utility as a function of the distance between her ideological position and the ideological position of the coalition scaled by the fervor of the society. For instance, consider that only two issues dominate the political space. The figure below categorizes Alice's ideology, coalition B's ideology, the fervor of society for each issue, and the resulting preference positions of Alice and coalition B.

---

[128] We assume that the utility is a recurring phenomenon. In other words, by supporting a coalition, one does not expect a 'lump sum' payment. Instead, one expects to enjoy recurring benefits or costs.

Issues	Issue One: Fervor = 7		Issue Two: Fervor = 2	
Actor	Ideology	Preference	Ideology	Preference
Alice	-0.3	-2.1	0.2	0.4
Coalition B	0	0	0.9	1.8

Figure A.3   Alice's and Coalition B's utility values

The two preference distances will determine the perceived distance, *x*, between Alice and coalition B. Again, note that we derive the preference position of Alice and coalition B by multiplying their ideological positions by the mean fervor of the society. For instance, Alice and coalition B have an ideological distance of 0.3 on issue one. However, because the fervor for the issue is seven, the preference distance between the two actors is 2.1. On issue two, Alice and coalition B are ideologically further apart than on issue one. They have a spread of 0.7. Yet, because this issue is a low fervor issue, Alice does not feel as distant from the coalition on this particular issue. The fervor scales the distance from 0.7 to 1.4. To find the total distance between Alice and coalition B, we simply take the Euclidean distance between Alice's preference position and coalition B's preference position. The result is a perceived distance of 2.52. Figure A.4 shows a graphical depiction of the process. Note that we easily generalize this concept into more than two dimensions. One should note that we can get Alice's preference position directly from her corresponding row in **P**. To get coalition B's preference position, we simply scale their ideological positions by the society's fervor for each issue.

The Preference Difference Between Alice and Coalition B

$$x = \sqrt{2.1^2 + 1.4^2} = 2.52$$
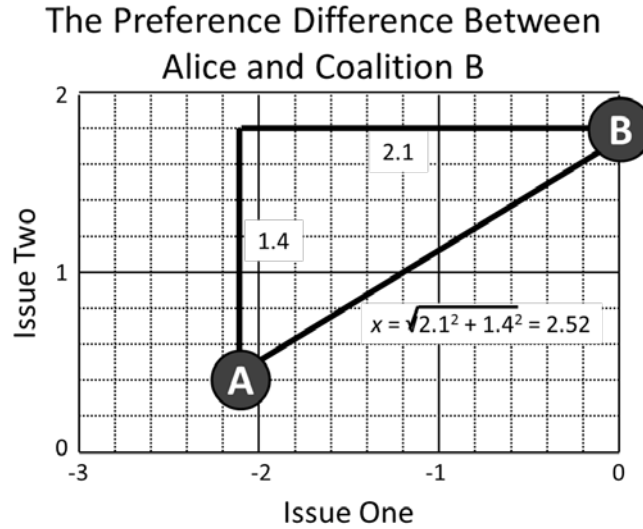
Figure A.4 Graphical depiction of preference difference between Alice and Coalition B.

Now, we have an objective measure of distance as a scalar value for any society with any number of *m* issues. Next, we need to know how to relate distance to perceived utility to get *u*. For our examples in both Chapters II and III, we assume a linear relationship. For instance, in *Doulah*, we use $u(x) = 3 - x$. We leave the science of finding the utility curve for a given society to economists and statisticians. However, we require a few constraints on *u* for our model to work properly. First, *u* must represent the aggregate utility for the entire society. Much like a demand curve represents aggregate demand—and hence does not claim to predict how Alice specifically will respond to changes in price—our utility curve captures the tendency of the society at large. Therefore, an attempt to quantify *u* should focus on a large sample. Second, a relationship exists between the scale of *u* and the scale of fervor. This will become more evident as we discuss the span of natural control and the range of normal politics. For now, one must understand that *u* is closely interrelated to fervor in society. Finally, *u* must be a non-increasing function on the domain of $x \in [0, \infty)$ with the co-domain $u(x) \in (-\infty, \infty)$. This ensures that the span of natural control and the range of normal politics are well-defined in a continuous domain.

2. Natural Control

With u thus defined, we can use it with **P** to determine the proportion of a population that we expect to support any given ideological position. Within the map, we expect that all constituents will support a coalition close enough to their preference position to offer a positive net utility. Therefore, we call the span of natural control the value of x for which $u(x) = 0$. Or, to be more rigorous, we consider the *supremum* of the subset of $u(x)$ for which $u(x)$ is greater than or equal to zero. This allows for the contingency that a continuous range of x values equal zero. With the span of control now defined by the utility curve, we can take any coalition with an ideological position scaled by the fervor of the society. We will call this m dimensional vector **c**. We can now solve for the natural control of **c**, c_ctrl, using the following pseudo code.

```
c_ctrl = 0;

for i=1:n

        if (norm(P(i,:) – c) <= span_ctrl)

        c_ctrl = c_ctrl + 1/n;

        end if

end for
```

This block of code will result with c_ctrl equaling the proportion of the population (from zero to one) who will offer their natural support to a coalition with the scaled ideological position **c**.

The utility curve gives us more than natural control. One can infer that an efficient coalition could alter the calculus of constituents who reside beyond its span of natural control with side payments. For instance, if Alice lives in *Doulah* where $u(x) = 3 – x$, if she is at a distance of 3.5 from coalition B, then she expects a net utility of negative one-half from supporting coalition B. She will not naturally support coalition B, given this incentive. Yet, the coalition might buy her support with a side payment of at least one-half. We call this artificial control. Now, we can use the utility curve to find

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artificial control given a budget of *bdgt* and a total population of *pop*.[129] To do so, we have to make some assumptions. First, we assume that the coalition is efficient in that it needs to spend only the deficit in utility in order to recruit artificial control. In our case of Alice, this implies that the coalition can buy her support for 0.5 dollars. Second, we assume that the coalition makes the strategic decision to spend their money recruiting constituents close to their position. In other words, they will spend their budget in order to recruit the greatest proportion of the population possible.

3. Artificial Control

To solve for artificial control, we use a two-step process. First, we find the range of artificial control that one can achieve for a given budget. Then, we determine the proportion of the population that resides between the span of natural control and the span of artificial control. The following pseudo code illustrates the process where *tol* is our tolerance for our numerical solution. This method uses an iterative method to efficiently locate the range of artificial control.

First, we must define a function to get the cost of recruiting support from a radius of *r1* to *r2* given a coalition at the scaled position **c** and the utility function *u*.

```
function cost=getcost(c, r1, r2)

    cost = 0;

    for i = 1:n

    d = norm(c – P(i,:));

    if (d > r1 && d <= r2)

        cost = cost - u(d);

    end if
```

---

[129] We need to know the total population to find out the proportion of the total population that we have represented by n. For instance, if Alice needs a side payment of one-half to support coalition B and our survey included 1,000 people in a country with a population of twenty million then we expect to find 20,000 (i.e., 20,000,000 / 1,000 = 20,000) other people that we have not surveyed for every Alice that we find. Therefore, we can assume that it actually costs 0.5 * 20,000 = 10,000 to recruit Alice under artificial control.

```
        end for

        cost = cost*pop/n;

    end
```

Now, we can solve for artificial control using the two step process described above. First, we will use an iterative search algorithm to find the radius of artificial control that we can achieve with a budget of *bdgt*.[130]

```
    loop = 1;

    a = span_ctrl;

    d = a;

    while loop

            if (getcost(c, d) < b)

            a = d;

            d = d*2;

            else

            loop = 0;

            end if

    end while

    loop = 1;

    b = d;

    while loop

            d = a + (b − a)/2;

            t = getcost(c, d) − bdgt;

            if (abs(t) < tol)
```

[130] Richard L. Burden and J. Douglas Faires, *Numerical Analysis, 8th edition* (Belmont: Thomson, 2005), 45–50.

```
        loop = 0;

        else if (t<0)

        a = d;

        else

        b = d;

        end if

    end while
```

At the end of this code, *d* is equal to the distance of artificial control that a coalition located at **c** can expect with a budget of *bdgt*. The second step is to find the amount of control that this has purchased for the coalition. We can do this by the following pseudo code. Note that *a_ctrl* is equal to artificial control and *d* is the distance that we calculated above.

```
    a_ctrl = 0;

    for i=1:n

            t = norm(c – P(i,:));

            if (t > span_ctrl && t < d)

            a_ctrl = a_ctrl + 1/n;

            end if

    end for
```

Therefore, with *u* we can find the proportion of natural and artificial control for a coalition with a given ideological position and budget for recruiting support.

D.   THE RANGE OF NORMAL POLITICS

Using the utility curve, we can also ascertain the point at which a constituency will devolve into violence over political rifts. Game theory has established a cost of

conflict incurred by belligerents who decide to settle disputes through violence.[131] We generalize this idea in considering that a rational individual will incur a cost in opposing the government. Therefore, if Alice perceives a net cost (i.e., a negative utility) in supporting coalition B, she will only rebel against the coalition if the costs of supporting the coalition exceed the cost of conflict.

On the utility curve, we can define the range of normal politics by solving for x such that $u(x)$ equals the cost of conflict (we assign a negative utility value to a cost). If we further restrict u to be strictly decreasing (as opposed to non-increasing), we can use a Golden Search algorithm to solve for the range of normal politics.

Figure A.5 displays an example of a non-linear utility curve in country C. In this case, we use the logistics equation below to find utility.

$$u(x) = \frac{41 \cdot 40e^{-0.5x}}{41 + 40(e^{-0.5x} - 1)} - 30$$

We assume a cost of conflict in this society of -25. Now, we can find the span of natural control by solving for $u(x) = 0$. Here, we find that $x = 5.39$ gives $u(x) = 0$. Thus, our span of natural control is 5.39. To find the range of normal politics, we solve for $u(x) + 25 = 0$. Similarly, we find that $x = 11.34$ is the range of normal politics. We expect that any constituent with a preference position within 5.39 of an adjacent coalition will offer his or her natural support to that coalition. Constituents between 5.39 and 11.34 from the coalition will not actively support the coalition, but they will also not break the law to oppose it. In other words, they will work for political change through legal means. However, constituents at a distance greater than 11.34 from a coalition will willfully break laws to oppose the coalition. To them, the cost of submission is greater than the cost of conflict.

---

[131] James Fearon, "Rationalist Explanations for War" *International Organization*, 49, no. 3 (1995): 379–384
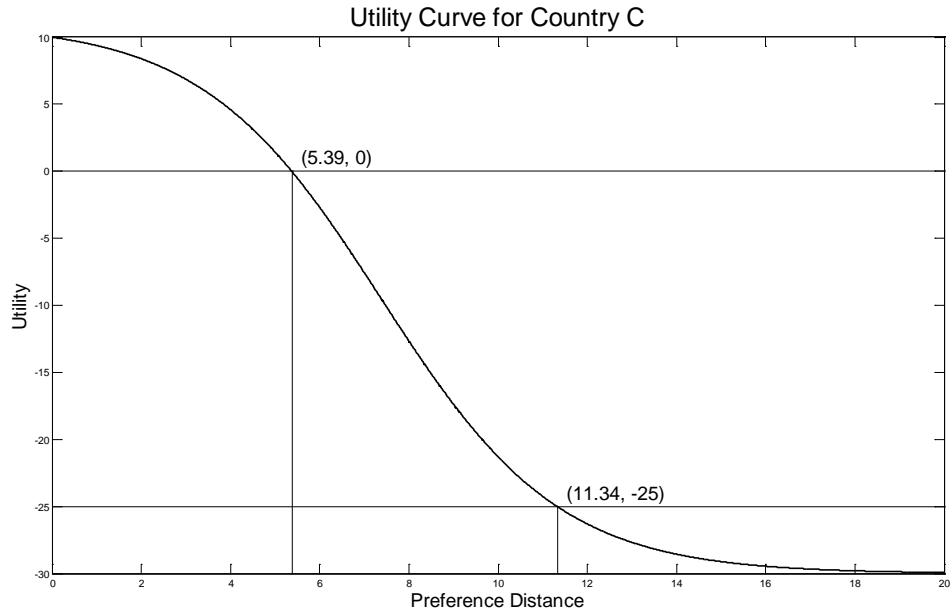
Figure A.5   The span of control and range of normal politics on a non-linear utility curve

E.   CONCLUSION

Using PCA, we can reduce a society in which *m* issues drive political divides into a two-dimensional contour map. This map serves as a tool for visualizing the potential coalitions in a society and the ways in which the issues build and break consensus. With the preferences of a society for the issues and the utility curve for the society, we can also ascertain the natural control that a coalition with a given ideology can expect to receive. Similarly, we can establish the proportion of artificial control that an efficient coalition can recruit for a given budget.

APPENDIX B: MATLAB CODE

A. PMAP

```
classdef pmap
    %Use this class to handle a population map

    properties

        %Basic parameters for storing survey data
        n;      %Number of respondents
        m;      %Number of issues
        imat;   %Identification matrix
        fmat;   %Fervor matrix
        smat;   %Scaled matrix
        fervor; %Fervor for each issue
        cspan;  %Span of control for society
        pop;    %Actual size of the population
        inames; %Issue names

        %Optional parameters for PCA
        pc1;    %Principal component 1
        pc2;    %Principal component 2
        sc1;    %Scale of response on pc1
        sc2;    %Scale of response on pc2
        pmat;   %smat projected onto pc1 and pc2
        dmat;   %Density matrix for pcs

        %Parameters for visualization options
        cres;   %Resolution to plot contour plots
        pres;   %Resolution for preference plots
        eqax;   %Axis equal boolean
        autol;  %Auto label graphs boolean

    end

    methods

        %Initialize a population map class object
        function pm=pmap(n,m)
            if nargin<2
                m=1;
            end
            if nargin<1
                n=1;
            end
            pm.n=n;
            pm.m=m;
            pm.imat=zeros(n,m);
            pm.fmat=zeros(n,m);
            pm.smat=zeros(n,m);
            pm.fervor=zeros(1,m);
```

```matlab
        pm.cspan=3;
        pm.pop=20000000;
        pm.pmat=zeros(n,2);
        pm.cres=15;
        pm.pres=10;
        pm.eqax=1;
        pm.autol=0;
        pm.dmat=zeros(2*pm.cres+1);
        pm.pc1=zeros(m,1);
        pm.pc2=zeros(m,1);
        pm.sc1=0;
        pm.sc2=0;
        td=['                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
            '                                              ';...
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            '                                              '];
        pm.inames=cellstr(td);
        for i=1:pm.m
            pm.inames(i)=strcat({'Issue '},num2str(i));
        end
    end

    %Load a map from survey results (identity and fervor)
    function pm=loaddat(pm,idat,fdat)
        pm.imat=idat;
        pm.fmat=fdat;
        pm=pm.update;
    end
```

```matlab
%Update smat based on imat and fmat
function pm=update(pm)
    [pm.n,pm.m]=size(pm.imat);
    for i=1:pm.m
        pm.fervor(i)=mean(pm.fmat(:,i));
    end
    for i=1:pm.m
        pm.smat(:,i)=pm.imat(:,i)*pm.fervor(i);
    end
    pm=pm.pca;
end


%Change fervor by f=f+N(mew,sig)
function pm=changef(pm,iss,mew,sig)
    pm.fmat(:,iss)=pm.fmat(:,iss)+sig*randn(pm.n,1)+mew;
    pm.fmat(:,iss)=pm.fmat(:,iss).*(pm.fmat(:,iss)>=0);
    pm=pm.update;
end


%Generate principle components
function pm=pca(pm)
    pc=princomp(pm.smat);
    pm.pc1=pc(:,1);
    pm.pc2=pc(:,2);

    %Create matrix of projections
    n1=norm(pm.pc1);
    n2=norm(pm.pc2);
    for i=1:pm.n
        pm.pmat(i,1)=pm.smat(i,:)*pm.pc1/n1;
        pm.pmat(i,2)=pm.smat(i,:)*pm.pc2/n2;
    end

    %Get the scale of the projections
    pm.sc1=ceil(max(abs(pm.pmat(:,1))));
    pm.sc2=ceil(max(abs(pm.pmat(:,2))));

    %Normalize pmat to range from -1 to 1
    pm.pmat(:,1)=pm.pmat(:,1)/pm.sc1;
    pm.pmat(:,2)=pm.pmat(:,2)/pm.sc2;

    %Create matrix for densities
    pm.dmat=zeros(2*pm.cres+1);
    for i=1:pm.n
        p1=round((pm.pmat(i,1)+1)*pm.cres)+1; %
        p2=round((pm.pmat(i,2)+1)*pm.cres)+1; %
        pm.dmat(p2,p1)=pm.dmat(p2,p1)+1/pm.n;
    end
end


%Return the size of a coalition with position c and control r
function s=getsize(pm,c,r)
    if nargin<3
        r=pm.cspan;
```

```
        end
        s=0;
        for i=1:pm.n
            if (norm(c-pm.smat(i,:))<=r)
                s=s+1/pm.n;
            end
        end
    end

    %Find the distance of artifical control for a given price
    function d=getdist(pm,c,p,tol)
        if nargin<4
            tol=10000;
        end
        loop=1;
        a=pm.cspan;
        d=a;
        while loop
            if pm.getcost(c,d)<p
                a=d;
                d=d*2;
            else
                loop=0;
            end
        end
        loop=1;
        b=d;
        while loop
            d=a+(b-a)/2;
            t=pm.getcost(c,d)-p;
            if abs(t)<tol
                loop=0;
            elseif t<0
                a=d;
            else
                b=d;
            end
        end
    end

    %Return cost of recruiting support from position c between a
    %and b
    function cost=getcost(pm,c,b,a)
        if nargin<4
            a=pm.cspan;
        end
        cost=0;
        for i=1:pm.n
            d=norm(c-pm.smat(i,:));
            if (d>a&&d<=b)
                cost=cost+d-a;
            end
        end
        cost=cost*pm.pop/pm.n;
    end
```

```
%Plot principle component plot
function pm=plotpc(pm)
    if sum(sum(pm.dmat))==0
        pm=pm.pca;
    end
    xint=-pm.sc1:pm.sc1/pm.cres:pm.sc1;
    yint=-pm.sc2:pm.sc2/pm.cres:pm.sc2;
    contourf(xint,yint,pm.dmat,pm.cres);
    if pm.autol
        xlabel('Primary Spectrum of Division','fontsize',18);
        ylabel('Secondary Spectrum of Division','fontsize',18);
        title('Population Map','fontsize',24);
    end
    if pm.eqax
        axis equal;
    end
    colormap('gray');
    colormap(flipud(colormap));
    set(gca,'color',[1,1,1]);
end

%Plot the preference interactions of two issues
function plotpint2(pm,i1,i2)
    pm.cres=pm.pres-1;
    tmat=zeros(2*pm.cres+1);
    for i=1:pm.n
        x=round((pm.imat(i,i1)+1)*pm.cres)+1; %
        y=round((pm.imat(i,i2)+1)*pm.cres)+1; %
        tmat(y,x)=tmat(y,x)+1/pm.n;
    end
    xint=-pm.fervor(i1):pm.fervor(i1)/pm.cres:pm.fervor(i1);
    yint=-pm.fervor(i2):pm.fervor(i2)/pm.cres:pm.fervor(i2);
    contourf(xint,yint,tmat,pm.cres);
    if pm.autol
        xlabel(pm.inames(i1),'fontsize',18);
        ylabel(pm.inames(i2),'fontsize',18);
        title('Preference Interaction Plot','fontsize',24);
    end
    if pm.eqax
        axis equal;
    end
    colormap('gray');
    colormap(flipud(colormap));
    set(gca,'Color',[1,1,1]);
end

%Plot the preference interations of several issues
function plotpintf(pm,iss)
    if nargin<2
        iss=1:pm.m;
    end
    t=pm.autol;
    pm.autol=0;
    x=length(iss);
```

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```
        ix=1;
        for i=iss
            jx=1;
            for j=iss
                if i==j
                    subplot(x,x,(ix-1)*x+jx);
                    pm.plotpbar(i);
                    if t
                        if ix==length(iss)
                            xlabel(pm.inames(j),'fontsize',14);
                        end
                        if jx==1
                            ylabel(pm.inames(i),'fontsize',14);
                        end
                    end
                else
                    subplot(x,x,(ix-1)*x+jx);
                    pm.plotpint2(j,i);
                    if t
                        if ix==length(iss)
                            xlabel(pm.inames(j),'fontsize',14);
                        end
                        if jx==1
                            ylabel(pm.inames(i),'fontsize',14);
                        end
                    end
                end
                jx=jx+1;
            end
            ix=ix+1;
        end
end

%Plot the ideology interactions of two issues
function plotiint2(pm,i1,i2)
    pm.cres=pm.pres-1;
    tmat=zeros(2*pm.cres+1);
    for i=1:pm.n
        x=round((pm.imat(i,i1)+1)*pm.cres)+1;
        y=round((pm.imat(i,i2)+1)*pm.cres)+1;
        tmat(y,x)=tmat(y,x)+1/pm.n;
    end
    xint=-1:1/pm.cres:1;
    yint=-1:1/pm.cres:1;
    contourf(xint,yint,tmat,pm.cres);
    if pm.autol
        xlabel(pm.inames(i1),'fontsize',18);
        ylabel(pm.inames(i2),'fontsize',18);
        title('Ideology Interaction Plot','fontsize',24);
    end
    if pm.eqax
        axis equal;
    end
    colormap('gray');
    colormap(flipud(colormap));
```

```matlab
        set(gca,'Color',[1,1,1]);
    end

%Plot the ideology interations of several issues
function plotiintf(pm,iss)
    if nargin<2
        iss=1:pm.m;
    end
    t=pm.autol;
    pm.autol=0;
    x=length(iss);
    ix=1;
    for i=iss
        jx=1;
        for j=iss
            if i==j
                subplot(x,x,(ix-1)*x+jx);
                pm.plotibar(i);
                if t
                    if ix==length(iss)
                        xlabel(pm.inames(j),'fontsize',14);
                    end
                    if jx==1
                        ylabel(pm.inames(i),'fontsize',14);
                    end
                end
            else
                subplot(x,x,(ix-1)*x+jx);
                pm.plotiint2(j,i);
                if t
                    if ix==length(iss)
                        xlabel(pm.inames(j),'fontsize',14);
                    end
                    if jx==1
                        ylabel(pm.inames(i),'fontsize',14);
                    end
                end
            end
            jx=jx+1;
        end
        ix=ix+1;
    end
end

%Plot a preference curve for one issue
function plotpden(pm,i)
    t=zeros(2*pm.pres+1,1);
    for j=1:pm.n
        x=round((pm.imat(j,i)+1)*pm.pres)+1; %
        t(x)=t(x)+1/pm.n;
    end
    t=t*pm.pres/pm.fervor(i);
    xint=-pm.fervor(i):pm.fervor(i)/pm.pres:pm.fervor(i);
    plot(xint,t,'-k');
    if pm.autol
```

```matlab
            xlabel('Preference Position','fontsize',18);
            ylabel('Population Density','fontsize',18);
            title(strcat({'Preference - '},pm.inames(i)),...
                'fontsize',24);
        end
end


%Plot a preference curve as a bar graph
function plotpbar(pm,i)
    t=zeros(2*pm.pres+1,1);
    for j=1:pm.n
        x=round((pm.imat(j,i)+1)*pm.pres)+1; %
        t(x)=t(x)+1/pm.n;
    end
    xint=-pm.fervor(i):pm.fervor(i)/pm.pres:pm.fervor(i);
    t=t*100;
    bar(xint,t,'facecolor',[.5,.5,.5]);
    if pm.autol
        xlabel('Preference Position','fontsize',18);
        ylabel('% Pop at Position','fontsize',18);
        title(strcat({'Preference - '},pm.inames(i)),...
            'fontsize',24);
    end
end


%Plot a ideology curve for one issue
function plotiden(pm,i)
    t=zeros(2*pm.pres+1,1);
    for j=1:pm.n
        x=round((pm.imat(j,i)+1)*pm.pres)+1; %
        t(x)=t(x)+1/pm.n;
    end
    t=t*pm.pres;
    plot([-1:1/pm.pres:1],t,'-k');
    if pm.autol
        xlabel('Ideology Position','fontsize',18);
        ylabel('Population Density','fontsize',18);
        title(strcat({'Ideology - '},pm.inames(i)),...
            'fontsize',24);
    end
end


%Plot a ideology curve for one issue
function plotibar(pm,i)
    t=zeros(2*pm.pres+1,1);
    for j=1:pm.n
        x=round((pm.imat(j,i)+1)*pm.pres)+1; %
        t(x)=t(x)+1/pm.n;
    end
    t=t*100;
    bar([-1:1/pm.pres:1],t,'facecolor',[.5,.5,.5]);
    if pm.autol
        xlabel('Ideology Position','fontsize',18);
        ylabel('% Pop at Position','fontsize',18);
        title(strcat({'Ideology - '},pm.inames(i)),...
```

```
                    'fontsize',24);
        end
end


%Draw a coalition's span of natural control
function plotc(pm,c,r,col)
    if nargin<4
        col=[0,0,0];
    end
    if nargin<3
        r=pm.cspan;
    end
    x=c*pm.pc1;
    y=c*pm.pc2;
    a=0:pi/50:2*pi;
    xp=r*cos(a);
    yp=r*sin(a);
    if pm.autol
        scatter(x,y,55,col,'+');
    end
    plot(x+xp,y+yp,'color',col,'linewidth',2);
end


%Draw a restricted circle
function plotcr(pm,c,ax,r,col)
    if nargin<5
        col=[0,0,0];
    end
    if nargin<4
        r=pm.cspan;
    end
    x=c*pm.pc1;
    y=c*pm.pc2;
    a=0:pi/50:2*pi;
    xp=r*cos(a);
    yp=r*sin(a);
    if pm.autol
        scatter(x,y,55,col,'+');
    end
    x1=xp(1);
    y1=yp(1);
    for i=2:length(a)
        xt=x1+x;
        yt=y1+y;
        xs=xp(i)+x;
        ys=yp(i)+y;
        if (xt>ax(1)&&xt<ax(2)&&yt>ax(3)&&yt<ax(4)&&...
                xs>ax(1)&&xs<ax(2)&&ys>ax(3)&&ys<ax(4))
            line([xt,xs],[yt,ys],'color',col,...
                'linewidth',2);
        end
        x1=xp(i);
        y1=yp(i);
    end
end
```

```
%Draw a coalition's label
function plotl(pm,c,lbl,sz,col)
    if nargin<5
        col=[0,0,0];
    end
    if nargin<4
        sz=14;
    end
    if nargin<3
        lbl='+';
    end
    x=c*pm.pc1;
    y=c*pm.pc2;
    text(x,y,lbl,'horizontalalignment','center',...
        'color',col,'fontsize',sz);
end

%Plot an issue
function ploti(pm,i,x,y,r)
    if nargin<5
        r=.5;
    end
    if nargin<4
        x=0;
        y=0;
    end
    a=0:pi/50:2*pi;
    xp=r*cos(a);
    yp=r*sin(a);
    plot(x+xp,y+yp,'color',[0,0,0],'linewidth',1);
    l=norm([pm.pc1(i),pm.pc2(i)]);
    line([x-pm.pc1(i)/l*r,x+pm.pc1(i)/l*r],...
        [y-pm.pc2(i)/l*r,y+pm.pc2(i)/l*r],...
        'color',[0,0,0],'linestyle','-','linewidth',2);
    xy=[.65*pm.pc1(i)/l*r;.65*pm.pc2(i)/l*r];
    a1=[cosd( 25),-sind( 25);sind( 25),cosd( 25)]*xy;
    a2=[cosd(-25),-sind(-25);sind(-25),cosd(-25)]*xy;

line([x+a1(1),x+pm.pc1(i)/l*r],[y+a1(2),y+pm.pc2(i)/l*r],...
            'color',[0,0,0],'linestyle','-','linewidth',2);

line([x+a2(1),x+pm.pc1(i)/l*r],[y+a2(2),y+pm.pc2(i)/l*r],...
            'color',[0,0,0],'linestyle','-','linewidth',2);
    line([x-pm.pc1(i)*r,x+pm.pc1(i)*r],...
        [y-pm.pc2(i)*r,y+pm.pc2(i)*r],...
        'color',[0,0,0],'linewidth',5);
    text(x,y-1.3*r,num2str(l),'horizontalalignment','center');
    if pm.autol
        text(x+1.2*r,y,pm.inames(i),'fontsize',14);
    end
end

end
```

```
    methods(Static)

        %Set a random seed
        function setseed(sd)
            s=RandStream('mcg16807','Seed',sd);
            RandStream.setGlobalStream(s);
        end

    end

end
```

B.   NUMSTACK

```
classdef numstack
    %this class creates a stack to push and pop numeric values.
    %the function 'pushq' serves as a queue, placing the data at the
    %end of the data.

    properties
        len;
        next;
        data;
    end

    methods
        function s=numstack(n,d,i)
            geti=false;
            if nargin<3
                geti=true;
                i=0;
            end
            if nargin<2
                d=NaN;
            end
            if nargin<1
                n=16;
            end
            s.len=n;
            s.data=zeros(n,1)*NaN;
            s.data(1:length(d))=d;
            s.next=i;
            if geti
                s.next=length(d)+1-1*isnan(d);
            end
        end

        function s=push(s,d)
            if s.next>s.len
                s=numstack(s.len*2,s.data,s.next);
            end
            s.data(2:s.next)=s.data(1:s.next-1);
            s.data(1)=d;
            s.next=s.next+1;
```

```
            end

        function s=pushq(s,d)
            if s.next>s.len
                s=numstack(s.len*2,s.data,s.next);
            end
            s.data(s.next)=d;
            s.next=s.next+1;
        end

        function [r,s]=pop(s)
            r=s.data(1);
            s.next=s.next-1;
            s.data(1:s.next-1)=s.data(2:s.next);
            s.data(s.next)=NaN;
        end

        function b=notempty(s)
            if s.next>1
                b=true;
            else
                b=false;
            end
        end

    end

end
```

C.   CHAPTER II EXAMPLES

```
% Chapter II, U.S. Example

%16 Issues
%1:  Pro Choice
%2:  Pro Marriage Equality
%3:  Pro 2nd Ammendment
%4:  Pro Free Market
%5:  Pro Social Welfare
%6:  Pro Social Medicine
%7:  Pro Federal System
%8:  Pro Union
%9:  Pro Military Intervention
%10: Pro Balanced Budget
%11: Pro Death Penalty
%12: Pro Environmental Protection
%13: Pro Nuclear Power
%14: Pro Defense
%15: Pro Legalized Drugs
%16: Pro Amnesty

%10,000 people surveyed for 16 issues
n=10000;
m=16;
```

```
amap=pmap(n,m);

%Positions on issues for six types of people
tn=6;
types=zeros(tn,2,m);

%Set span of natural control
amap.cspan=3.5;

%Issues           1    2    3    4    5    6    7    8    9    10   11
12   13   14   15

%Type  1, 30%, Republican
types( 1,:,:)=[-.50,-.25, .58, .63,-.48,-.03, .08,-.45, .41, .56, .64,-
.12, .52, .78,-.25,-.50;... %mean position
                .32, .46, .31, .21, .54, .62, .45, .19, .50, .22, .44,
.56, .18, .13, .55, .32];   %standard deviation

%Type  2, 30%, Democrat
types( 2,:,:)=[ .41, .65,-.54, .22, .51, .68,-.13, .59,-.58,-.21,-.45,
.62,-.12, .11, .25, .41;... %mean position
                .28, .34, .30, .36, .52, .24, .55, .20, .54, .32, .31,
.48, .38, .43, .45, .28];   %standard deviation

%Type  3, 10%, Libertarian
types( 3,:,:)=[ .40, .72, .47, .65,-.63,-.38, .41,-.45,-.43, .61, .03,
.21, .72, .16, .63, .40;... %mean position
                .42, .31, .48, .31, .41, .42, .15, .23, .25, .33, .84,
.57, .13, .53, .21, .42];   %standard deviation

%Type  4, 15%, Blue Dog Democrats
types( 4,:,:)=[ .03,-.13, .47, .33, .41, .55, .04, .48, .38,-.13, .58,-
.32, .41, .69,-.34, .03;... %mean position
                .55, .48, .42, .30, .49, .28, .55, .23, .53, .32, .39,
.47, .38, .33, .47, .55];   %standard deviation

%Type  5,  7%, Tea Party
types( 5,:,:)=[-.65,-.37, .71, .70,-.57,-.43, .58,-.51, .36, .67, .66,-
.15, .56, .57,-.36,-.65;... %mean position
                .21, .38, .29, .31, .51, .51, .26, .29, .53, .27, .34,
.36, .35, .43, .62, .21];   %standard deviation

%Type  1,  8%, Moderate Independent
types( 6,:,:)=[   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
0,   0,   0,   0,   0;... %mean position
                .25, .25, .25, .25, .25, .25, .25, .25, .25, .25, .25,
.25, .25, .25, .25, .25];   %standard deviation

%Percentage breakdowns for types
ptype=[.30,.30,.10,.15,.07,.08];

%Get breaks based on percentages of types
btype=zeros(tn,1);
```

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```
btype(1)=ptype(1);
for i=2:tn
    btype(i)=btype(i-1)+ptype(i);
end

%Get positions for each group
pos=zeros(tn,m);
for i=1:tn;
    for j=1:m;
        pos(i,j)=types(i,1,j);
    end
end

%Set the seed
amap.setseed(0);

%Generate identity/ideology matrix
for i=1:n

    %Find out what type of person to generate
    r=rand;
    loopc=1;
    type=1;
    while loopc
        if r<=btype(type)
            loopc=0;
        else
            type=type+1;
        end
    end

    %Generate imat based on this person
    for j=1:m-1
        loopc=1;
        while loopc
            t=types(type,2,j)*randn+types(type,1,j);
            if abs(t)<=1
                loopc=0;
            end
        end
        amap.imat(i,j)=roundn(t,-2);
    end

    %Generate 16th issue with strong correlation to first
    loopc=1;
    while loopc
        amap.imat(i,16)=amap.imat(i,1)+.4*(1-
abs(amap.imat(i,1)))*randn;
        if abs(amap.imat(i,16))<=1
            loopc=0;
        end
    end

end
```

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```
%Label issues
amap.inames( 1)={'Pro Choice'};
amap.inames( 2)={'Pro Marriage Equality'};
amap.inames( 3)={'Pro 2nd Ammendment'};
amap.inames( 4)={'Pro Free Market'};
amap.inames( 5)={'Pro Social Welfare'};
amap.inames( 6)={'Pro Social Medicine'};
amap.inames( 7)={'Pro Federal System'};
amap.inames( 8)={'Pro Union'};
amap.inames( 9)={'Pro Military Intervention'};
amap.inames(10)={'Pro Balanced Budget'};
amap.inames(11)={'Pro Death Penalty'};
amap.inames(12)={'Pro Environmental Protection'};
amap.inames(13)={'Pro Nuclear Power'};
amap.inames(14)={'Pro Defense'};
amap.inames(15)={'Pro Legalized Drugs'};
amap.inames(16)={'Pro Amnesty'};


%Set fervor without using distributions
amap.fmat(:, 1)=ones(n,1)*2.3;
amap.fmat(:, 2)=ones(n,1)*1.8;
amap.fmat(:, 3)=ones(n,1)*0.4;
amap.fmat(:, 4)=ones(n,1)*3.7;
amap.fmat(:, 5)=ones(n,1)*3.5;
amap.fmat(:, 6)=ones(n,1)*4.8;
amap.fmat(:, 7)=ones(n,1)*0.5;
amap.fmat(:, 8)=ones(n,1)*1.8;
amap.fmat(:, 9)=ones(n,1)*1.9;
amap.fmat(:,10)=ones(n,1)*5.2;
amap.fmat(:,11)=ones(n,1)*0.2;
amap.fmat(:,12)=ones(n,1)*1.2;
amap.fmat(:,13)=ones(n,1)*0.4;
amap.fmat(:,14)=ones(n,1)*1.8;
amap.fmat(:,15)=ones(n,1)*0.7;
amap.fmat(:,16)=ones(n,1)*1.1;


%Update map with span of control
amap=amap.update;

%Set resolutions
amap.pres=15;
amap.cres=15;


%Save an image of the map
save USPopMap


%%% Initial Map is Now Generated %%%


%Figure 2.5
figure;
load USPopMap;
amap.autol=1;
amap.eqax=1;
```

```
subplot(2,3,1);
amap.plotpbar(1);
axis([-3,3,0,7]);
subplot(2,3,4);
amap.plotpbar(16);
axis([-3,3,0,7]);
subplot(2,3,[2,3,5,6]);
amap.plotpint2(1,16);
clear;


%Figure 2.6
load USPopMap;
hold off;
bmap=pmap(n,2);
bmap.imat=amap.imat(:,[1,16]);
bmap.fmat=amap.fmat(:,[1,16]);
bmap=bmap.update;
bmap.autol=1;
bmap.eqax=1;
bmap.inames(1)=amap.inames(1);
bmap.inames(2)=amap.inames(16);
subplot(2,3,1);
bmap.plotpbar(1);
text(-2.5,6.5,'A','fontsize',20);
subplot(2,3,4);
bmap.plotpbar(2);
axis([-3,3,0,7]);
text(-2.5,6.5,'B','fontsize',20);
subplot(2,3,2);
bmap.plotpint2(1,2);
text(-2,1.5,'C','fontsize',20);
subplot(2,3,5);
hold on;
bmap.plotpc;
for i=1:2
    bmap.ploti(i,-5+2.7*i,-1.25,.3);
end
text(-2.5,1.5,'D','fontsize',20);
subplot(2,3,[3,6]);
res=10;
p=bmap.smat*bmap.pc1/norm(bmap.pc1);
s=max(abs(p));
x=-s:s/res:s;
y=zeros(length(x),1);
for i=1:n
    t=round(((p(i)+s)/s)*res)+1;
    y(t)=y(t)+1/n;
end
bar(x,y*100,'facecolor',[.5,.5,.5]);
xlabel('Conservative                    Liberal','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
title('One Dimensional Map','fontsize',24);
text(-2.5,7.5,'E','fontsize',20);
clear;
```

```
%Figure 2.7 Plot the map with all 16 issue projections
figure;
load USPopMap;
amap.autol=0;
amap.eqax=1;
amap.plotpc;
hold on;
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
title('U.S. Population Map: Phase 0','fontsize',24);
amap.autol=1;
axis([-8,15,-8,8]);
for i=1:m
    amap.ploti(i,9,8.5-i,.32);
end
amap.plotc(pos(1,:).*amap.fervor);
amap.plotc(pos(2,:).*amap.fervor);
lbls=['R','D','L','B','T'];
for i=1:tn-1
    amap.plotl(pos(i,:).*amap.fervor,lbls(i),26,[1,1,1]);
end
text(-5,-4,strcat({'Size of Republican Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(1,:).*amap.fervor),-2)),...
    '%'),'fontsize',20);
text(-5,-4.7,strcat({'Size of Democratic Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(2,:).*amap.fervor),-2)),...
    '%'),'fontsize',20);
clear;


%Figure 2.8
load USPopMap;

%Set fervor without using distributions
amap.fmat(:, 1)=ones(n,1)*2.3;
amap.fmat(:, 2)=ones(n,1)*1.8;
amap.fmat(:, 3)=ones(n,1)*4.4;
amap.fmat(:, 4)=ones(n,1)*3.7;
amap.fmat(:, 5)=ones(n,1)*3.5;
amap.fmat(:, 6)=ones(n,1)*5.3;
amap.fmat(:, 7)=ones(n,1)*0.5;
amap.fmat(:, 8)=ones(n,1)*1.8;
amap.fmat(:, 9)=ones(n,1)*1.9;
amap.fmat(:,10)=ones(n,1)*5.2;
amap.fmat(:,11)=ones(n,1)*0.2;
amap.fmat(:,12)=ones(n,1)*1.2;
amap.fmat(:,13)=ones(n,1)*0.4;
amap.fmat(:,14)=ones(n,1)*1.8;
amap.fmat(:,15)=ones(n,1)*0.7;


%Update map with span of control
amap=amap.update;

%Plot map
amap.autol=0;
amap.eqax=1;
```

```
amap.plotpc;
hold on;
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
title('U.S. Population Map: Phase 1','fontsize',24);
amap.autol=1;
axis([-10,18,-8,8]);
for i=1:m
    amap.ploti(i,10.75,8.5-i,.30);
end
amap.plotc(pos(1,:).*amap.fervor);
amap.plotc(pos(2,:).*amap.fervor);
lbls=['R','D','L','B','T'];
for i=1:tn-1
    col=[0,0,0];
    if i==2
        col=[1,1,1];
    end
    amap.plotl(pos(i,:).*amap.fervor,lbls(i),14,col);
end
text(-5,-4,strcat({'Size of Republican Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(1,:).*amap.fervor),-2)),...
    '%'),'fontsize',16);
text(-5,-4.7,strcat({'Size of Democratic Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(2,:).*amap.fervor),-2)),...
    '%'),'fontsize',16);
clear;

%Figure 2.9
load USPopMap;

%Set fervor without using distributions
amap.fmat(:, 1)=ones(n,1)*2.3;
amap.fmat(:, 2)=ones(n,1)*1.8;
amap.fmat(:, 3)=ones(n,1)*2.4;
amap.fmat(:, 4)=ones(n,1)*3.7;
amap.fmat(:, 5)=ones(n,1)*3.5;
amap.fmat(:, 6)=ones(n,1)*8.3;
amap.fmat(:, 7)=ones(n,1)*0.5;
amap.fmat(:, 8)=ones(n,1)*1.8;
amap.fmat(:, 9)=ones(n,1)*1.9;
amap.fmat(:,10)=ones(n,1)*5.2;
amap.fmat(:,11)=ones(n,1)*0.2;
amap.fmat(:,12)=ones(n,1)*1.2;
amap.fmat(:,13)=ones(n,1)*0.4;
amap.fmat(:,14)=ones(n,1)*1.8;
amap.fmat(:,15)=ones(n,1)*0.7;

%Update map with span of control
amap=amap.update;

%Plot map
figure
amap.autol=0;
amap.eqax=1;
```

```
amap.plotpc;
hold on;
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
title('U.S. Population Map: Phase 2','fontsize',24);
amap.autol=1;
axis([-10,21,-8,10]);
for i=1:m
    amap.ploti(i,11.75,10.5-1.05*i,.3);
end
amap.plotc(pos(1,:).*amap.fervor);
amap.plotc(pos(2,:).*amap.fervor);
lbls=['R','D','L','B','T'];
for i=1:tn-1
    col=[0,0,0];
    if i==2
        col=[1,1,1];
    end
    amap.plotl(pos(i,:).*amap.fervor,lbls(i),14,col);
end
text(-5,-5.5,strcat({'Size of Republican Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(1,:).*amap.fervor),-2)),...
    '%'),'fontsize',16);
text(-5,-6.2,strcat({'Size of Democratic Coalition = '},...
    num2str(roundn(100*amap.getsize(pos(2,:).*amap.fervor),-2)),...
    '%'),'fontsize',16);
clear;
```

D. CHAPTER III EXAMPLES

```
% Chapter III

%Six Issues in country Harbahlea
%1: Ethnic Identity, Low Fervor
%2: Equal Protection, Low Fervor
%3: Political Representation, Low Fervor
%4: Free Market, Med Fervor
%5: Constitutional Freedoms, Med Fervor
%6: Opposition to Occupation, No Fervor

%10,000 people surveyed
n=10000;
m=6;
dmap=pmap(n,m);

%Generate fervor and ideologies for these six issues based on a
%hypothetical population based on 9 different types of people. The code
%below lists the mean position and the standard deviation for each of
these
%types of people and the comments give their proporition of the society
and
%a brief description of their coalition.

%Positions on issues for ten types of people
```

```
tn=10;
types=zeros(tn,2,m);

%Issues            1    2    3    4    5    6

%Type  1, 5%, hardcore supporters (ethnic minority)
types( 1,:,:)=[-.75,-.81,-.90,-.30,-.72, .80;... %mean position
               .11, .12, .04, .16, .12, .25];   %standard deviation


%Type  2, 3%, hardcore opposition (ethnic majority)
types( 2,:,:)=[ .85, .91, .93, .91, .95,-.95;... %mean position
               .11, .09, .04, .12, .11, .45];   %standard deviation


%Type  3, 12%, government smypathiser (ethnic minority)
types( 3,:,:)=[-.77,-.60,-.69,-.20,-.78, .91;... %mean position
               .28, .32, .28, .37, .19, .18];   %standard deviation


%Type  4, 11%, government sympathiser (ethnic majority)
types( 4,:,:)=[ .58, .30,-.05,-.05,-.20, .68;... %mean position
               .31, .32, .28, .43, .53, .35];   %standard deviation


%Type  5, 3%, liberal elite (ethnic minority)
types( 5,:,:)=[-.52, .51, .30, .34, .60, .14;... %mean position
               .45, .63, .51, .41, .36, .74];   %standard deviation


%Type  6, 7%, liberal elite (ethnic majority)
types( 6,:,:)=[ .62, .71, .42, .47, .93,-.67;... %mean position
               .35, .39, .49, .29, .34, .51];   %standard deviation


%Type  7, 13%, frustrated youth (ethnic minority)
types( 7,:,:)=[-.20, .41, .55, .77, .52, .84;... %mean position
               .28, .32, .41, .34, .32, .30];   %standard deviation


%Type  8, 24%, frustrated youth (ethnic majority)
types( 8,:,:)=[ .28, .61, .60, .81, .61, .48;... %mean position
               .29, .26, .39, .17, .29, .33];   %standard deviation


%Type  9, 1%, opposition (ethnic minority)
types( 9,:,:)=[-.52, .21, .18, .37, .11, .48;... %mean position
               .45, .39, .47, .35, .39, .61];   %standard deviation


%Type 10, 21%, opposition (ethnic majority)
types(10,:,:)=[ .90, .25, .32, .49, .18,-.37;... %mean position
               .32, .52, .40, .41, .36, .67];   %standard deviation


%Percentage breakdowns for types
ptype=[.05,.03,.12,.11,.03,.07,.13,.24,.01,.21];

%Get breaks based on percentages of types
btype=zeros(tn,1);
btype(1)=ptype(1);
for i=2:tn
    btype(i)=btype(i-1)+ptype(i);
```

```
end

%Get positions for each group
pos=zeros(tn,m);
for i=1:tn;
    for j=1:m;
        pos(i,j)=types(i,1,j);
    end
end

%Set the seed
dmap.setseed(0);

%Generate identity/ideology matrix
for i=1:n

    %Find out what type of person to generate
    r=rand;
    l=1;
    type=1;
    while l
        if r<=btype(type)
            l=0;
        else
            type=type+1;
        end
    end

    %Generate imat based on this person
    l=1;
    while l
        i1=types(type,2,1)*randn+types(type,1,2);
        i2=types(type,2,2)*randn+types(type,1,2);
        i3=types(type,2,3)*randn+types(type,1,3);
        i4=types(type,2,4)*randn+types(type,1,4);
        i5=types(type,2,5)*randn+types(type,1,5);
        i6=types(type,2,6)*randn+types(type,1,6);
        if (abs(i1)<=1&&abs(i2)<=1&&abs(i3)<=1&&abs(i4)<=1&&...
                abs(i5)<=1&&abs(i6)<=1)
            l=0;
        end
    end
    dmap.imat(i,1)=roundn(i1,-1);
    dmap.imat(i,2)=roundn(i2,-1);
    dmap.imat(i,3)=roundn(i3,-1);
    dmap.imat(i,4)=roundn(i4,-1);
    dmap.imat(i,5)=roundn(i5,-1);
    dmap.imat(i,6)=roundn(i6,-1);

    %Generate fervor for issue
    dmap.fmat(i,1)=0.683727397260277;
    dmap.fmat(i,2)=2.164695652173919;
    dmap.fmat(i,3)=0.793663492063505;
    dmap.fmat(i,4)=2.615500000000002;
```

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```
        dmap.fmat(i,5)=0.573458139534889;
        dmap.fmat(i,6)=0.249504500000000;


end


%Label issues
dmap.inames(1)={'Ethnicity'};
dmap.inames(2)={'Equal Protection'};
dmap.inames(3)={'Political Representation'};
dmap.inames(4)={'Free Market'};
dmap.inames(5)={'Constitutional Freedom'};
dmap.inames(6)={'Opposition to Occupation'};


%Update the map
dmap=dmap.update;


%Get initial fervor levels
finit=dmap.fervor;


%Save the data
save DPopData;


%%%%%%%%%%%%%%%%%%
%%% MAP CREATED %%%
%%%%%%%%%%%%%%%%%%


%Plot Figure 3.1, the ideology an pref curves for pol rep and free
markets
load DPopData;
dmap.autol=1;
subplot(1,3,1);
dmap.plotibar(3);
axis([-6,6,0,15]);
xlabel('Ideology Position','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
title(strcat({'A. Ideology - '},dmap.inames(3)),'fontsize',14);
dmap.fmat(:,3)=.3;
dmap=dmap.update;
subplot(1,3,2);
dmap.plotpbar(3);
axis([-6,6,0,15]);
xlabel('Preference Position','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
title(strcat({'B. Preference - '},dmap.inames(3),{' Low Fervor'}),...
     'fontsize',14);
text(-5,10,strcat({'Fervor =
'},num2str(dmap.fervor(3))),'fontsize',16);
dmap.fmat(:,3)=5;
dmap=dmap.update;
subplot(1,3,3);
dmap.plotpbar(3);
axis([-6,6,0,15]);
xlabel('Preference Position','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
```

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```
title(strcat({'C. Preference - '},dmap.inames(3),{' Moderate
Fervor'}),...
    'fontsize',14);
text(-5,10,strcat({'Fervor =
'},num2str(dmap.fervor(3))),'fontsize',18);
dmap.fmat(:,3)=finit(3);
dmap=dmap.update;
clear;


%Plot Figure 3.2, the ideology and pref curves for all
load DPopData;
figure;
dmap.autol=0;
for i=1:5
    subplot(2,5,i);
    dmap.plotibar(i);
    axis([-1,1,0,15]);
    xlabel('Ideology Position','fontsize',14);
    ylabel('% Pop at Position','fontsize',14);
    title(strcat(dmap.inames(i),{' - A'}),'fontsize',18);
end
for i=1:5
    subplot(2,5,5+i);
    dmap.plotpbar(i);
    axis([-3,3,0,15]);
    xlabel('Preference Position','fontsize',14);
    ylabel('% Pop at Position','fontsize',14);
    title(strcat(dmap.inames(i),{' - B'}),'fontsize',18);
end

%Plot Figure 3.3, the utility curve
figure;
x=0:.1:15;
y=3-x;
hold on;
line([ 0,15],[  0, 0],'color',[.5,.5,.5]);
line([ 3, 3],[-15, 0],'color',[.5,.5,.5]);
line([12,12],[-15, 0],'color',[.5,.5,.5]);
line([ 0,12],[ -9,-9],'color',[.5,.5,.5]);
plot(x,y,'-k','linewidth',3);
text( 0.1, -8.25,'Cost of Conflict = 9','fontsize',14);
text(12.1,-14.25,'Range of Normal Politics = 12','fontsize',14);
text( 3.1,-14.25,'Span of Natural Control = 3','fontsize',14);
xlabel('Distance from Coalition to Constituent','fontsize',18);
ylabel('Expected Utility of Constituent','fontsize',18);
title('Utility Curve for Doulah','fontsize',24);
axis([0,15,-15,4]);
set(gca,'xtick',[  1:1:15]);
set(gca,'ytick',[-15:3: 3]);
clear;


%Plot Figure 3.4
```

```
load DPopData;
figure;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah at Incipient Stage','fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
dmap.plotc(pos(1,:).*dmap.fervor,5,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
axis([-4,7.75,-4,4]);
for i=1:5
    dmap.ploti(i,4.75,4.1-1.3*i);
end
text(6,3.75,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
text(-2,2,'Span of Natural Control = 3','backgroundcolor',[1,1,1],...
    'fontsize',14);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-2,1.7,strcat({'Population Under Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(0,3.6,'Artificial Control =
5','backgroundcolor',[1,1,1],'fontsize'...
    ,14);
s=dmap.getsize(pos(1,:).*dmap.fervor,5);
t=s-t;
text(0,3.3,strcat({'Population Under Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,5);
text(0,3.0,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;

%Figure 3.5
load DPopData;
figure;
dmap.eqax=1;
dmap.autol=1;
subplot(1,3,1);
axis([-2,2,0,10]);
dmap.plotibar(5);
dmap.autol=0;
subplot(1,3,2);
dmap.plotpbar(5);
xlabel('Preference Position','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
title('Pre Arab Spring Preference','fontsize',24);
axis([-2,2,0,10]);
dmap.fmat(:,3)=1.799479162416334*ones(n,1);
dmap.fmat(:,4)=3.112272117820786*ones(n,1);
dmap.fmat(:,5)=1.569195521239901*ones(n,1);
dmap=dmap.update;
subplot(1,3,3);
```

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```matlab
dmap.plotpbar(5);
xlabel('Preference Position','fontsize',18);
ylabel('% Pop at Position','fontsize',18);
title('Post Arab Spring Preference','fontsize',24);
axis([-2,2,0,10]);
clear;

%Figure 3.6, Increase fervor
load DPopData;
figure;
cost=dmap.getcost(pos(1,:).*dmap.fervor,5);
dmap.fmat(:,3)=1.799479162416334*ones(n,1);
dmap.fmat(:,4)=3.112272117820786*ones(n,1);
dmap.fmat(:,5)=1.569195521239901*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah during Arab Spring','fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
d=dmap.getdist(pos(1,:).*dmap.fervor,cost,10000);
dmap.plotc(pos(1,:).*dmap.fervor,d,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
axis([-4,9,-4,4]);
for i=1:5
    dmap.ploti(i,6,4.1-1.3*i);
end
text(7,3.75,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
text(-3,2.5,'Span of Natural Control = 3','backgroundcolor',[1,1,1],...
    'fontsize',14);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-3,2.2,strcat({'Population Under Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(0,3.6,strcat({'Artificial Control = '},num2str(roundn(d,-2))),...
    'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,d);
t=s-t;
text(0,3.3,strcat({'Population Under Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,d);
text(0,3.0,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
dmap.plotl(pos(8,:).*dmap.fervor,'O',14,[1,1,1]);
clear;

%Figure 3.7 Government over-reacts
load DPopData;
figure;
cost=dmap.getcost(pos(1,:).*dmap.fervor,5);
dmap.fmat(:,2)=6.179321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
```

```
dmap.fmat(:,4)=3.313388525836377*ones(n,1);
dmap.fmat(:,5)=5.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah After Regime Reaction','fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
d=dmap.getdist(pos(1,:).*dmap.fervor,cost,10000);
dmap.plotc(pos(1,:).*dmap.fervor,12,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor,d,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
axis([-9,17,-8,8]);
for i=1:5
    dmap.ploti(i,11,7.5-2.2*i,.75);
end
text(14,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
text(-8.5,-4,'Span of Natural Control =
3','backgroundcolor',[1,1,1],...
    'fontsize',14);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-4.75,strcat({'Population Under Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-7,7,strcat({'Artificial Control = '},num2str(roundn(d,-2))),...
    'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,d);
t=s-t;
text(-7,6.25,strcat({'Population Under Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,d);
text(-7,5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
text(1,-7,'Range of Normal Politics = 12','backgroundcolor',...
    [1,1,1],'fontsize',14);
dmap.plotl(pos(8,:).*dmap.fervor,'O',24,[1,1,1]);
dmap.plotl(pos(2,:).*dmap.fervor,'I',24,[1,1,1]);
clear;


%Figure 3.8, The Opposition Forms
load DPopData;
figure;
gcost=dmap.getcost(pos(1,:).*dmap.fervor,5);
icost=128000;
dmap.fmat(:,2)=6.179321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
dmap.fmat(:,4)=3.313388525836377*ones(n,1);
dmap.fmat(:,5)=5.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
```

```
dmap.plotpc;
title('Population Map of Doulah at Start of Civil War','fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(2,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,9,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,9,-8,8]);
dmap.plotl(pos(8,:).*dmap.fervor,'O',14,[1,1,1]);
dmap.plotl(pos(2,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-9,17,-8,8]);
for i=1:5
    dmap.ploti(i,11,7.5-2.2*i,.75);
end
text(14,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-4,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-5,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(2,:).*dmap.fervor);
text(2,-4,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(2,:).*dmap.fervor,id);
t=s-t;
text(2,-5,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(2,:).*dmap.fervor,id);
text(2,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;


%Figure 3.9
load DPopData;
figure;
gcost=dmap.getcost(pos(1,:).*dmap.fervor,5);
icost=128000;
dmap.fmat(:,1)=5.194321056378921*ones(n,1);
dmap.fmat(:,2)=6.179321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
dmap.fmat(:,4)=1.313388525836377*ones(n,1);
dmap.fmat(:,5)=5.080968343767496*ones(n,1);
```

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```
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah with Growing Ethnic Tension',...
    'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(2,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,10,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,10,-8,8]);
dmap.plotl(pos(8,:).*dmap.fervor,'O',14,[1,1,1]);
dmap.plotl(pos(2,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-10,17,-8,8]);
for i=1:5
    dmap.ploti(i,11,7.5-2.2*i,.75);
end
text(14,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-4,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-5,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(2,:).*dmap.fervor);
text(2,-4,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(2,:).*dmap.fervor,id);
t=s-t;
text(2,-5,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(2,:).*dmap.fervor,id);
text(2,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;

%Figure 3.10
load DPopData;
figure;
gcost=dmap.getcost(pos(1,:).*dmap.fervor,5);
icost=640000;
```

```
dmap.fmat(:,1)=5.194321056378921*ones(n,1);
dmap.fmat(:,2)=6.179321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
dmap.fmat(:,4)=1.313388525836377*ones(n,1);
dmap.fmat(:,5)=5.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah with Increasing Insurgent
Resources',...
    'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(2,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,10,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(2,:).*dmap.fervor,[-9,10,-8,8]);
dmap.plotl(pos(8,:).*dmap.fervor,'O',14,[1,1,1]);
dmap.plotl(pos(2,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-10,17,-8,8]);
for i=1:5
    dmap.ploti(i,11,7.5-2.2*i,.75);
end
text(14,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-4,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-5,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(2,:).*dmap.fervor);
text(2,-4,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(2,:).*dmap.fervor,id);
t=s-t;
text(2,-5,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(2,:).*dmap.fervor,id);
text(2,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;
```

```
%Figure 3.11
load DPopData;
figure;
gcost=dmap.getcost(pos(1,:).*dmap.fervor,5);
icost=640000;
dmap.fmat(:,1)=5.194321056378921*ones(n,1);
dmap.fmat(:,2)=6.179321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
dmap.fmat(:,4)=1.313388525836377*ones(n,1);
dmap.fmat(:,5)=5.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah with Insurgent Shift in Platform',...
    'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(8,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(8,:).*dmap.fervor,[-9,10,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-9,10,-8,8]);
dmap.plotl(pos(8,:).*dmap.fervor,'O',14,[1,1,1]);
axis([-10,17,-8,8]);
for i=1:5
    dmap.ploti(i,11,7.5-2.2*i,.75);
end
text(14,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-4,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-5,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(8,:).*dmap.fervor);
text(2,-4,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-4.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(8,:).*dmap.fervor,id);
t=s-t;
text(2,-5,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
```

```
t=dmap.getcost(pos(8,:).*dmap.fervor,id);
text(2,-5.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;


%Figure 3.12
load DPopData;
figure;
gcost=dmap.getcost(pos(1,:).*dmap.fervor,5);
icost=640000;
dmap.cres=dmap.cres;
dmap.fmat(:,1)=8.294321056378921*ones(n,1);
dmap.fmat(:,2)=6.479321668171707*ones(n,1);
dmap.fmat(:,3)=2.795269258725330*ones(n,1);
dmap.fmat(:,4)=1.313388525836377*ones(n,1);
dmap.fmat(:,5)=4.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah with Fractured Insurgency',...
    'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(8,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(8,:).*dmap.fervor,[-12,12,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-12,12,-8,8]);
dmap.plotl(pos( 8,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-12,20,-8,8]);
for i=1:5
    dmap.ploti(i,13,7.5-2.2*i,.75);
end
text(16,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-5,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-5.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-6,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-6.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(8,:).*dmap.fervor);
text(2,-5,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-5.5,strcat({'Range of Artificial Control = '},...
```

```
        num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(8,:).*dmap.fervor,id);
t=s-t;
text(2,-6,strcat({'Insurgent Artificial Control = '},...
        num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(8,:).*dmap.fervor,id);
text(2,-6.5,strcat({'Cost of Artificial Control = $'},...
        num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;

%Figure 3.13
load DPopData;
figure;
nato=[0,.95,.75,.70,.95,-.90];
gcost=640000;
icost=640000;
ncost=2000000;
dmap.cres=dmap.cres;
dmap.fmat(:,1)=3.294321056378921*ones(n,1);
dmap.fmat(:,2)=2.479321668171707*ones(n,1);
dmap.fmat(:,3)=1.795269258725330*ones(n,1);
dmap.fmat(:,4)=5.313388525836377*ones(n,1);
dmap.fmat(:,5)=1.080968343767496*ones(n,1);
dmap.fmat(:,6)=4.249504500000000*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah Four Years Post Invasion',...
        'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(8,:).*dmap.fervor,icost,10000);
nd=dmap.getdist(nato.*dmap.fervor,ncost,10000);
dmap.plotcr(pos(1,:).*dmap.fervor,[-9,9,-7,7],gd,[.5,.5,.5]);
dmap.plotcr(pos(1,:).*dmap.fervor,[-9,9,-7,7]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-9,9,-7,7],id,[.5,.5,.5]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-9,9,-7,7]);
dmap.plotcr(nato.*dmap.fervor,[-9,9,-7,7]);
dmap.plotcr(nato.*dmap.fervor,[-9,9,-7,7],nd,[.5,.5,.5]);
dmap.plotl(pos(1,:).*dmap.fervor,'G',14,[1,1,1]);
dmap.plotl(pos(8,:).*dmap.fervor,'I',14,[1,1,1]);
dmap.plotl(nato.*dmap.fervor,'N',14,[0,0,0]);
axis([-9,17,-7,7]);
for i=1:6
        dmap.ploti(i,10,7.5-2.2*i,.75);
end
text(11,7,'Issue Projections','horizontalalignment','center',...
        'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-5,strcat({'Government Natural Control = '},...
        num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
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text(-8.5,-5.5,strcat({`Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-6,strcat({`Government Artificial Control = '},...
    num2str(t*100),{` %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-6.5,strcat({`Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(8,:).*dmap.fervor);
text(2,-5,strcat({`Insurgent Natural Control = '},...
    num2str(t*100),{` %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-5.5,strcat({`Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(8,:).*dmap.fervor,id);
t=s-t;
text(2,-6,strcat({`Insurgent Artificial Control = '},...
    num2str(t*100),{` %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(8,:).*dmap.fervor,id);
text(2,-6.5,strcat({`Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;


%Figure 3.14
load DPopData;
figure;
gcost=5000000;
icost=640000;
dmap.cres=dmap.cres;
dmap.fmat(:,1)=12.494321056378921*ones(n,1);
dmap.fmat(:,2)=6.479321668171707*ones(n,1);
dmap.fmat(:,3)=3.795269258725330*ones(n,1);
dmap.fmat(:,4)=1.313388525836377*ones(n,1);
dmap.fmat(:,5)=2.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title(`Population Map of Doulah with Non-Lethal Aid',...
    'fontsize',24);
xlabel(`Primary Spectrum of Division','fontsize',18);
ylabel(`Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(8,:).*dmap.fervor,icost,1000);
dmap.plotc(pos(1,:).*dmap.fervor,gd,[.5,.5,.5]);
dmap.plotc(pos(1,:).*dmap.fervor);
dmap.plotcr(pos(8,:).*dmap.fervor,[-12,12,-8,8],id,[.5,.5,.5]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-12,12,-8,8]);
dmap.plotl(pos( 1,:).*dmap.fervor,'G',14,[1,1,1]);
dmap.plotl(pos( 8,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-15,22,-8,8]);
for i=1:5
    dmap.ploti(i,16,7.5-2.2*i,.75);
```

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end
text(18.5,7,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-5,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-5.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-6,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-6.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(8,:).*dmap.fervor);
text(2,-5,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-5.5,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(8,:).*dmap.fervor,id);
t=s-t;
text(2,-6,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(8,:).*dmap.fervor,id);
text(2,-6.5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;


%Figure 3.15
load DPopData;
figure;
gcost=1000000;
icost=10000000;
dmap.cres=dmap.cres;
dmap.fmat(:,1)=6.494321056378921*ones(n,1);
dmap.fmat(:,2)=4.479321668171707*ones(n,1);
dmap.fmat(:,3)=3.795269258725330*ones(n,1);
dmap.fmat(:,4)=5.313388525836377*ones(n,1);
dmap.fmat(:,5)=3.080968343767496*ones(n,1);
dmap=dmap.update;
hold on;
dmap.eqax=1;
dmap.autol=0;
dmap.plotpc;
title('Population Map of Doulah with Lethal and Non-Lethal Aid',...
    'fontsize',24);
xlabel('Primary Spectrum of Division','fontsize',18);
ylabel('Secondary Spectrum of Division','fontsize',18);
dmap.autol=1;
gd=dmap.getdist(pos(1,:).*dmap.fervor,gcost,10000);
id=dmap.getdist(pos(8,:).*dmap.fervor,icost,1000);
dmap.plotcr(pos(1,:).*dmap.fervor,[-11,11,-6,6],gd,[.5,.5,.5]);
dmap.plotcr(pos(1,:).*dmap.fervor,[-11,11,-6,6]);
dmap.plotcr(pos(8,:).*dmap.fervor,[-11,11,-6,6],id,[.5,.5,.5]);
```

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dmap.plotcr(pos(8,:).*dmap.fervor,[-11,11,-6,6]);
dmap.plotl(pos( 1,:).*dmap.fervor,'G',14,[1,1,1]);
dmap.plotl(pos( 8,:).*dmap.fervor,'I',14,[1,1,1]);
axis([-11,17,-6,6]);
for i=1:5
    dmap.ploti(i,12,6.2-2.2*i,.75);
end
text(14,5.5,'Issue Projections','horizontalalignment','center',...
    'fontsize',18);
t=dmap.getsize(pos(1,:).*dmap.fervor);
text(-8.5,-3.5,strcat({'Government Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(-8.5,-4,strcat({'Range of Artificial Control = '},...
    num2str(roundn(gd,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(1,:).*dmap.fervor,gd);
t=s-t;
text(-8.5,-4.5,strcat({'Government Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(1,:).*dmap.fervor,gd);
text(-8.5,-5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,5))),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getsize(pos(8,:).*dmap.fervor);
text(2,-3.5,strcat({'Insurgent Natural Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
text(2,-4,strcat({'Range of Artificial Control = '},...
    num2str(roundn(id,-2))),'backgroundcolor',[1,1,1],'fontsize',14);
s=dmap.getsize(pos(8,:).*dmap.fervor,id);
t=s-t;
text(2,-4.5,strcat({'Insurgent Artificial Control = '},...
    num2str(t*100),{' %'}),'backgroundcolor',[1,1,1],'fontsize',14);
t=dmap.getcost(pos(8,:).*dmap.fervor,id);
text(2,-5,strcat({'Cost of Artificial Control = $'},...
    num2str(roundn(t,3))),'backgroundcolor',[1,1,1],'fontsize',14);
clear;
```

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